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AND PATTERN MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

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BRITISH FOUNDRYMEN'S ASSOCIATION.
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Manchester: A. Harrison, 705, Manchester Road, Castletown.
Birmingham: C. Grindlay, 39, Copeley Hill, Erdington, Birmingham.
Sheffield and District: J. Dickinson, 157, Abbeyfield, Road, Pitsmoor, Sheffield.
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London: Alexander Hayes, 165, Strand, London, W.C.
Halifax: J. G. Robinson, 17, Gibraltar Road, Halifax.
Newcastle-on-Tyne: H. A. J. Rang, Cleveland Road, North Shields.
East Midlands: H. Pemberton, 15, Wolfa Street, Derby.

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NOTES AND COMMENTS.

Defective Castings and Liability.

A discussion on the liability for defective castings and the cost of machining them was recently published in the American technical Press. It arose from a question as to whether a foundry can be held liable in the case of a defective casting where the defect is not discovered until considerable work has been done on the piece, and material destroyed. The crux of the question was whether or not foundrymen are expected to make any allowance for the cost of the machining in such cases. The manufacturer who supplied the castings agreed to replace them, but would not allow for lost labour. The specification in a case cited provided for the usual chemical and physical properties and tests of the castings, demanded good sound iron, free from flaws, blow-holes, fins, cold-shuts or shrinkage cracks, etc., but as to those which failed to meet requirements, simply stipulated that they would be rejected and returned to the founder at his expense.

The production manager of a motor-car plant gave the following views:—"The answer can be based on the standard practice according to which vendors establish their prices; they replace anything defective as received by the purchaser, but replace labour upon the repair of defective products only on specific agreement to that effect. If we, in our business, wilfully start material into production that later proves defective, we do not claim any losses except that of the part as received from the vendor, because our contracts and agreements do not contain a provision enabling us to do otherwise. Such provision would, of course, necessitate higher prices. Goods are usually sold on the assumption that they are good; if not, that they will be replaced. But since the vendor has absolutely no control over the cost of labour engaged by a purchaser on defective goods, it is self-evident that he should not be called upon to assume responsibility for such work done."

These expressions of opinion will, we think, be approved of by most foundrymen, and one foundry manager confirmed them in the following statement:—"Our general custom is that we agree to replace all castings which may prove defective, but do not allow for the cost of labour spent on them. There are times, however, when, by allowing an expenditure of a small amount, we can save the casting and in this case we are usually willing to pay this amount. When a customer stipulates that machine work spent on defective castings be deducted from bills, we arrange to make our price sufficient to cover the possibility of such a deduction." Another foundry manager said:—"Our custom, and we believe it is universal, is not to allow any machine work on castings that prove to be defective. We go further and will not allow any machine work that may be done in order to make castings that are imperfect usable unless this is arranged beforehand."

The case is perhaps best summed up in the words of another foundryman, who remarked that the justice of the common practice of foundries replacing such castings as prove defective after being machined

but to pay no machining cost can be readily seen from the fact that the purchaser of the castings can tell by preliminary inspection, just as well as the foundryman can tell, whether or not the castings are defective. It is not fair to charge the foundryman with the expense of machining castings which he did not know were defective and had no means of ascertaining.

But one very important feature of the case was not mentioned in the discussion, viz., the question of design and effect on soundness. There are some users who insist on rigid adherence to their design in every detail, even when inherent unsoundness and weakness is involved. We have often seen users refusing to allow trifling and unimportant structural modifications which would convert an extremely difficult casting into a readily-produced one, merely through ignorance of the elements of casting design. If such a casting is made to the user's specification it may or may not be good; but if the defect is one which can only be discovered after machining it is hardly fair to inflict all the penalty on the founder.

Methods of Technical Education.

As soon as conditions allow the subject of technical education to come up for proper consideration, much discussion will turn on the value of practical instruction in classes such as is given in various engineering, carpentry and similar technical courses. There is certainly room for such discussion, particularly in respect to the nature and prominence of that instruction in relation to book and lecture work, and each trade will require its own solution to the question. Discussing the place of science in education before the Royal Society of Arts recently, Prof. A. J. Fleming remarked that in some schools a great show is made with carpenters' or engineering workshops. "This," he said, "impresses parents and attracts boys with a mechanical turn of mind; but there is little or no real scientific training in it. The making of a model steam-engine is an amusement for leisure hours or wet half-holidays, but is perfectly useless as a means of scientific education for boys. The school work should be confined to imparting a really practical and thorough knowledge of elementary principles of science. Of course, in all this the quality and kind of teaching given is the important factor. The mode in which a subject is taught is even of more importance than the subject itself. Chemistry can be so imperfectly taught as to be of little use a mind-training. It is possible to give a very scientific lesson on a Greek verb, and also to give a lesson on an electrical machine which is not scientific teaching at all. Hence here, as elsewhere, the man counts for more than the machine or apparatus. Nevertheless, the good teacher is wasted unless he has the necessary appliances."

In accepting Professor Fleming's dictum as it stands, however, one is liable to overlook the value of practical operations in teaching the very elementary principles which he desires to impart. This is mentioned in a recent issue of "The British Westinghouse Gazette," in which is given an account of the trade school for apprentices that has been established for some time at the Westinghouse works, Trafford Park, Manchester. The British Westinghouse Company opened this school for their apprentices because they found the manual training received by them in the course of their progress through the workshops was not sufficiently wide in its scope to turn out a properly skilled craftsman, thoroughly competent in his vocation. It is explained that the "apprenticeship system consisting wholly of manual training was competent to do this in past times when engineering products were not standardised, and when the immense output of similar parts had not called into being the automatic and semi-automatic machinery of to-day. The educational value of explanations respecting work which is being done contemporaneously by the pupils is far greater than any number of lectures on apparatus with which they are not familiar, and a national system of this kind would prove superior to the Municipal and Governmental technical schools of the Fatherland, that have been so well advertised."

In the foundry trade a somewhat similar condition exists. It is not only necessary to impart knowledge of scientific principles, but also principles of working practice with which the student does not come into contact in his every day work; and in so doing it is much easier to instruct him in the science of his calling. The practical classes referred to by Prof. Fleming may require very severe modification and improvement, but the system of imparting knowledge by the practical application of principles is, in its essentials, quite sound.

Female Labour in the Foundry.

The introduction of female labour into the foundry (apart from the core department) has given rise to a good deal of criticism and comment, for it has come rather as a shock to our established notions. Some critics have referred to foundry work as degrading to womanhood and strongly deprecated the innovation. It is certain that, under normal conditions, prejudice would have been too strong to sanction the expedient; but since national exigencies have necessitated the departure it is well to inquire whether the charge of degradation is founded on fact. An occupation can be degrading either mentally, morally or physically: mentally if it stunts the mental development or produces warped development by reason of wrong incentives; morally if it encourages or presents debased conceptions; and physically if the labour is unsuited to the physique of the individual. It is to be feared that the conditions under which many industries, beside founding, are conducted tend to stunt mental development, or at least fail to encourage it, and in many of those industries female labour has long been a prominent factor. So far as moral degradation is concerned, the object and nature of the industry is the dominant factor, and no one would seriously contend that an honest attempt to serve the nation in its need necessarily involves moral degradation. It would rather be agreed that "*Pro Patria*" should be the keynote of the nation's moral code. As regards the physical aspect of the question, that turns essentially on the organisation of the work in which women are employed, and the nature of the operations, whether arduous or otherwise. Like the manhood, the womanhood of a nation is a collection of physiques of greatly varying capabilities, and, given that the employment is not too strenuous and taxing (having regard to the primary functional distinction between the sexes), there need be nothing degrading in any employment which has for its object a right and honourable aim. If the same squeamishness were exhibited against sending young and immature lads to work under the conditions existing in some foundries, there might be an excuse for the objection to the introduction of female labour; but the main complaint in the past has been that the lads have not developed their capabilities as desired by their employers, though the conditions of their work were not held responsible.

British Foundrymen's Association.

ANNUAL GENERAL MEETING.

The annual meeting of the British Foundrymen's Association was held at the Connaught Rooms, Kingsway, London, on Saturday, June 24; Mr. W. Mayer, the retiring President, in the chair.

THE PRESIDENT, in opening the proceedings, extended a hearty welcome to the members and expressed his pleasure at seeing them so interested in the work of the Association. He had no need to mention the strenuous times in which we were living. All true Britons were doing their best for the country either in fighting or in other ways. In visiting the Branches during his year of office he was pleased to note the good work they were doing—work which would be a lasting credit to them in many respects and which would redound to the credit of the Association and its Branches for years after this crisis. Remembering how this work was being done, at a time when everybody's thoughts were occupied with the war, it demonstrated that the British Fondrymen's Association was coming to be appreciated in the right way, and he hoped it would continue to go on in that way to still greater progress in the future.

MR. J. ELLIS.
(President of the British Foundrymen's Association).

The SECRETARY then read the minutes of the last annual meeting.

On the motion of MR. S. A. GIMSON, seconded by MR. F. J. COOK, the minutes were signed as correct.

Annual Report of Council for 1915.

Six General Council meetings have been held at the following places:—Birmingham, Derby, Leeds, London, Manchester and Sheffield; and members have attended from Birmingham, Cardiff, Chesterfield, Derby, Dumbarton, Falkirk, Gateshead, Halifax, Leicester, London, Luton, Manchester, Sheffield, Stoke, Warrington and West Bromwich.

The Literary Committee has reviewed Papers given before the Branches during the previous session, and awards for the best Papers were published and diplomas given. The Papers given during last session will shortly be reviewed.

Notwithstanding the many duties and distractions inseparable from the prosecution of a great war, the Branches are doing excellent and valuable work for the foundry trade. Many interesting Papers have been read and discussed, and visits to various works have been much appreciated by the members.

The new Branch formed for the East Midlands held a series of lectures at Derby and Leicester, and it is hoped next session to include in the programme lectures at Nottingham and Loughborough.

Six members of the General Council are retiring and are eligible for re-election. According to the new rule, however, there are only five vacancies on the General Council. The following have been nominated:—Messrs. W. H. Hatfield, C. Heggie, G. B. Henderson, H. Jewson, T. Macfarlane, J. Oswald, H. L. Reason and J. Smith.

The Council regrets that owing to the printers' works having been destroyed by fire, the "Proceedings" had to be entirely reprinted, thus causing the delay in delivery.

The total number of members on the roll of the Association at the end of 1915 was 965, aganst 1,047 in the previous year. The members consist of 7 Honorary Life Members, 7 Life Members, 220 Members, 501 Associate Members, 230 Associates. Twenty-three Members, 85 Associate Members and 61 Associates have resigned or ceased to become members, and 22 Members, 53 Associate Members and 12 Associates have been elected.

The respective Branches have the following members attached to them:—

	Members.	Assoc. Members.	Associates.	Total.
Birmingham ...	12 (12)	64 (77)	47 (55)	123
East Midlands ...	18 (17)	38 (32)	16 (14)	70
Halifax	10 (13)	19 (33)	23 (31)	52
Lancashire ...	33 (37)	91 (95)	33 (33)	157
London	40 (50)	52 (64)	13 (22)	105
Newcastle ...	29 (2·)	46 (43)	26 (30)	101
Sheffield	40 (35)	83 (74)	20 (21)	143
Scottish	36 (28)	89 (93)	52 (69)	177

The figures in brackets indicate the previous year's membership.

The accounts for the year ended December 31, 1915, are now submitted, having been duly audited by Messrs. Frank Creke, Harcourt & Company, Birmingham, the auditors appointed by the Council.

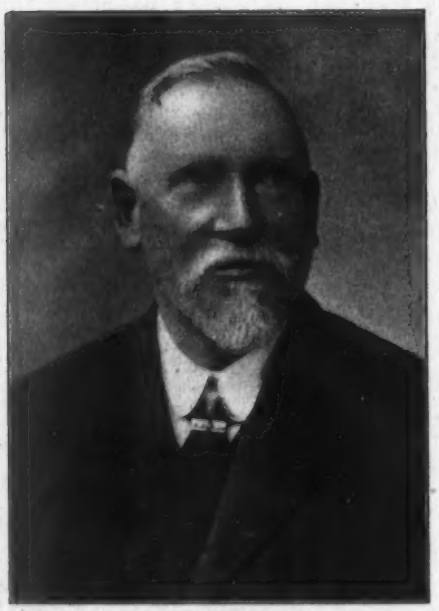
INCOME AND EXPENDITURE ACCOUNT, JANUARY 1 to DECEMBER 31, 1915.

EXPENDITURE.

	£ s. d.	£ s. d.
Postages		32 6 5
Printing and Stationery (including printing of Proceedings)		96 4 3
Council, Finance, and Annual Meeting Expenses		12 15 0
Branch Expenses, viz.:		
Lancashire	13 10 0	
Sheffield	21 2 6	
Scottish	13 15 10	
Newcastle	21 4 5	
Birmingham	15 18 10	
London	29 1 7	
Halifax	7 15 3	
East Midlands	11 9 3½	
		133 17 8½
Illuminated Addresses		9 9 0
Audit Fee		4 4 0
Clerical Assistance		12 10 0
Incidental Expenses		14 16 7
Apprentices' Committee		1 7 10
Honorarium to Secretary		42 0 0
Bank Charges		0 4 0
Balance—being excess of Income over Expenditure for the year		71 9 2½
		£431 4 0

INCOME

	£ s. d.
Subscriptions received	431 0 6
Sale of Books, &c.	0 3 6
	£431 4 0



Mr W. Mayer.

(Past-President of the British Foundrymen's Association).

BALANCE-SHEET, DECEMBER 31, 1915.

LIABILITIES.

	£ s. d.	£ s. d.
Subscriptions paid in advance		27 0 0
Sundry Creditors		57 5 4
Surplus as at 31st December, 1914	154 14 6	
Excess of Income over Expenditure for the year ended 31st December, 1915	71 9 2½	
		226 3 8½
		£310 9 0½

NOTE.—There are arrears of Subscriptions amounting to £155 15s. 6d. which are not included in these Accounts.

ASSETS.

	£ s. d.	£ s. d.
Cash in hands of Secretaries, viz.:		
Lancashire	5 7 0	
Sheffield	6 10 9½	
Scottish	8 8 0	
Birmingham	2 3 1	
London	5 2 6	
East Midlands	1 10 8½	
General Secretary	17 7 2½	
	46 9 3½	
Less Balance due to Newcastle Secretary	5 6 3	
		41 3 0½
London City & Midland Bank, Ltd.		250 12 6
Furniture, Fixtures, and Fittings		18 13 6
		£310 9 0½

Mr. T. H. Firth.

(Senior Vice-President of the British Foundrymen's Association).

On the motion of Mr. C. Jones, seconded by Mr. R. Buchanan, the balance sheet was adopted.

Election of President.

Mr. T. Firth said it gave him very much pleasure to propose that Mr. J. Ellis be asked to be the new President. Most of the members knew Mr. Ellis probably better than he did. He was one of the enthusiasts who started the Association, and he believed that in 1904, when he was living in Southampton, he journeyed all the way to Birmingham to be at the meeting when the formation of the Association was proposed. He had been a member of the Council ever since, and they knew the good work he had done. Like most others, Mr. Ellis had had a very trying time during the past two years, and many of them had not been able to give the amount of attention to the affairs of the Association they would have wished to. Nevertheless, they must all agree that the Association had gone ahead very well indeed, and Mr. Ellis had been untiring in his efforts to help in every possible way.

Mr. Mayer endorsed all that Mr. Firth had said about Mr. Ellis. He had known him for the full length of the life of the Association, and he

knew how anxious and earnest he was that the Association should continue to prosper. There was not the least doubt that Mr. Ellis would carry on the duties of President and the work of the Association if not better than they had been certainly equal to the best that had been.

Mr. Finch, in supporting the proposition, remarked that the very first letter he received in response to his correspondence with regard to forming the British Foundrymen's Association came from Mr. Ellis.

The motion was put to the meeting and carried with acclamation.

Mr. Ellis then took the Presidential Chair.

Mr. Mayer, in vacating the chair, said it was a very pleasant duty to invite Mr. Ellis to take his place. The office of President was the highest honour that could be conferred in the foundry trade, and it was one he himself had appreciated very much. He hoped that every successor to the office would have the same feelings and be as proud of the position as he had been.

the Association ever since it had its being, and he should always continue to do so. It was his very great privilege, as well as pleasure, to accept the chain of office that Mr. Mayer had so kindly presented to the Association. It was a gift they would all remember as long as the Association remained in existence, and they wished to thank Mr. Mayer for it, not so much for its intrinsic value—although that must be very great—but for the motive which actuated him in making the gift. That motive they all deeply recognised and very highly appreciated. It was another mark of the proof, if proof were necessary, of Mr. Mayer's great and lively interest in the British Foundrymen's Association, and they all hoped that Mr. Mayer would be spared for many years to enjoy the best of health and remain with them to give the Association the benefit of his wide experience and wise counsel, and also to instil in the members a more fervent desire to carry on the good work in which he (Mr. Mayer) had played so great and so noble a part.

Presidential Chain of Office, Presented by Mr. W. Mayer.

Chain of Office.

Mr. Mayer, continuing, said he wished to present to the Association a chain of office for the use of the President for the time being. It was being given through a deed of gift in order that all details and possibilities might be arranged for. It was a great pleasure to him to do this for the Association, and whilst he had not been able to wear it himself he was just as pleased that his successors would be able to.

The chain of office was then placed on Mr. Ellis.

Finally, Mr. Mayer said it should be left in the hands of the past presidents to arrange some simple rules of the routine of how and when the chain should be used. He also thought it should be insured. He thanked the members for the kindness they had shown in putting him in the Presidential Chair last year.

The President (Mr. Ellis) thanked the members sincerely for the honour they had bestowed upon him, and not only for the honour but also for the confidence that had been placed in him. That confidence he would always value very much indeed. He had always taken a very deep interest in

Mr. Mayer, responding to the vote of thanks, said he was as pleased to give the chain of office as the members were to receive it.

Election of Vice-Presidents.

Mr. R. Buchanan, in proposing Mr. T. H. Firth for the office of Vice-President, said that he needed very little introduction. The name of Firth in Sheffield was a household word, and they would all agree that Mr. Firth carried on the traditions of that name in a most admirable fashion. Mr. Firth was a most welcome addition to the forces of the Council, and there was no one who had been in contact with him but was struck with his ability and keen business qualities and when, in course of time, he came to the Presidential Chair, he would have an opportunity for giving full play to those abilities.

Mr. F. J. Cook expressed his pleasure in seconding the proposition. Last year when he had proposed Mr. Firth as Junior Vice-President he had pointed out that he would bring to play on the business side of the Association very great ability, and he was quite sure that had turned out to be

the case. It would be the more so as Mr. Firth took a more prominent position in the Association.

The proposition was carried with acclamation.

MR. FIRTH, in thanking the members for his election, expressed himself anxious to help forward the affairs of the Association in any way he possibly could.

MR. F. J. COOK then proposed Mr. J. A. Little as Junior Vice-President. Since Mr. Little came to the Council he had done excellent work and had shown himself a very capable man, although, perhaps, he was not so well known to the ordinary members as he was to the Council.

MR. J. E. H. ALLBUT, who seconded, said that although Mr. Little was a young member of the Council, anyone who had sat beside him at Council meetings quickly realised that he was a man of great ability. He was one of the great enthusiasts of the foundry world, and a representative of Sheffield.

The election was unanimously agreed to.

MR. LITTLE expressed his thanks.

Treasurer.

MR. MAYER, in proposing the re-election of Mr. Finch, said he was sure he would be echoing the sentiments of everyone and would not offend Mr. Finch if he called him their "Grand Old Man." He was the pioneer of the Association.

MR. JONES seconded, and the motion having been carried with acclamation, MR. FINCH, in thanking the members for their continued confidence in him, gave a short report of his trusteeship during the eight years he had been treasurer. In conclusion he stated that the income in 1916 up to date had been £147 15s. and the expenditure £85 16s. 7d., leaving a balance of £61 18s. 5d., and with the bank balance of £250 12s. 6d. there was a total of £312 10s. 11d. Out of this a £200 Exchequer Bond had been taken up, leaving a bank balance of £112 10s. 11d. In June he received from the bank manager 12s. 8d. on behalf of the Exchequer Bond, which made the total £113 3s. 7d. In conclusion he again heartily thanked the members for re-electing him, and he hoped he would continue to do his best, as he had done in the past.

MR. R. BUCHANAN proposed Mr. E. H. Pilkington as secretary, and MR. MAYER seconded. The resolution was carried with acclamation.

The deed of gift in respect of the chain of office was then signed, and MR. MAYER said that therein was a clause whereby, should the British Foundrymen's Association ever be disbanded or dissolved and not be carried on by any similar association, the chain would become the property of the Governors of the Technical College at Glasgow for the special use of the Professor of Metallurgy for the time being.

Presentation to Mr. Gimson.

The PRESIDENT then asked Mr. Mayer to make a presentation.

MR. MAYER said he had been requested to present to Mr. Gimson, their Past-President, a handsome illuminated address in book form. They all knew how worthy Mr. Gimson was of this gift. He had worked most strenuously for the Association, and no member could surpass what he had done in the way of giving the Association a status, and specially in the Midlands. He had been the means of causing the foundry trade to be looked up to and had been a very persistent advocate of everything for the furtherance of the progress of the British Foundrymen's Association in season and out of season. The majority of the members knew what an important public man he was in his own town of Leicester, one of the most go-ahead for doing and thinking in the Midlands. He had done many things for the Association in his genial, happy way, which was well worthy of imitation by everyone. The illuminated address by no means recompensed him for all he had done, but they had fallen in with his wish that the address should be in the form of a book, and he was very pleased it had been carried out in such an elaborate way.

MR. GIMSON, in acknowledging the address, said that the fact the Association showed such confidence in him as to elect him President for two years was one of the happiest and one of the proudest things in his life, and the very beautiful address would be a memento of that happy time. Contrary to what Mr. Mayer had said, the address did recompense him amply for anything he had been able to do, in that it would serve as a reminder of their confidence in and kindness to him. That, indeed, was a great deal more than recompense for anything he could possibly have done for the Association. The address was in rather a new form, viz., instead of being in the usual form for framing it was in the form of a book. As some of his friends knew, he was a bit mad on books, and he really liked it better in that form, and he therefore thanked them for that particular consideration.

MR. R. BUCHANAN pointed out that the address was made under the superintendence of Mr. Fletcher, Principal of the Leicester School of Art, and anyone who examined it would see that it really was a work of art in its true sense.

THE PRESIDENT announced the following result of the voting for five new members of Council:—Messrs. W. H. Hatfield, H. Jewson, T. McFarlane, J. Oswald, and H. L. Reason.

On the motion of MR. R. BUCHANAN, seconded by MR. FIRTH, Messrs. Frank Creke, Harcourt & Company were re-elected auditors.

Presidential Address.

THE PRESIDENT then delivered his address, in the course of which he said:—

As one who has been in close connection with the inner working of the Association since its inception, I should like to pay a tribute of praise and honour to those men who by their incessant labour and untiring devotion have raised it to its present position and steered its course of development through many devious ways. The personal influence and devotion of my predecessors in office have contributed in no small degree to the influential and important position which the Association now occupies; for their ungrudging labours, coupled with the experience and wise counsel of the officers of both the parent Council and the Branches have given it a sound business and financial foundation on which to build its work. The names of the gentlemen who have been responsible for this development will be handed down to posterity as pioneers of a great educational movement. These men have given their best to the world for the benefit of any who wish to profit by it. All honour to them.

During the past twelve years much light of an intensely interesting and remarkably profitable character has been thrown upon foundry matters through the instrumentality of the Association. The spade work of education in the early days was heavy, for there had to be faced the prejudices of generations and the general conception—since proved dangerously false—that to impart knowledge of the

craft to others was to endanger one's own position. It has been difficult to convince many foundrymen how small is the value of one man's knowledge and experience unless supplemented by the experience of others; and even now there are many who proceed along the lines of self-satisfied secretiveness, content to believe that they have nothing to gain and everything to lose by free discussion of the founders' craft. Perhaps the most important initial work the Association has done is in showing the immense range of difficulties with which the founder is every day coping. A first essential in any improvement is the indication of defects; and if the past decade of effort has done no more it has at least brought to light a multitude of serious problems of everyday practice which call for serious attention and solution. But the past decade has done far more than reveal problems; it has been a decade of solid progress. Looking back on the early discussions before the Association there is apparent a startling vagueness of ideas on even elementary matters among foundrymen, and moreover, serious discrepancies and differences in practice which could only have resulted from lack of association with fellow workers.

The relation of metallurgical knowledge to foundrywork was scarcely understood at all, and the few who attempted to establish any connection between them were regarded rather as cranks than as practical workers. So far as scientific knowledge was concerned, there existed practically a sharp division between those who considered that the chemist possessed a panacea for all the ills that founders are heir to, and those who regarded all men of scientific and chemical attainments as rather irritating incumbrances. To-day we find the founder frankly accepting the help offered by the scientist, and in turn freely criticising the latter's work as to its practical bearing; while the scientist, with perhaps a greater humility than before, in turn acknowledges that practical application is in truth the touchstone of scientific research. There is no question but that this co-operation between the two classes of workers is largely due to the work of the Association, for it has afforded unique opportunities of intimate contact between practical and scientific workers.

In practical works research and experiment, also, the Association has played an important part; for it has stimulated many founders to apply to their own particular problems that effort of logical experiment and enquiry which is essential in progress, and the publication of the results has been of untold benefit to the craft generally. This same practice of investigation under working conditions, moreover, is steadily spreading, for the Association is teaching founders that while the laboratory can contribute much to foundry knowledge, the foundry itself can contribute a part no less important. The future will undoubtedly see greater co-ordination of these laboratory and practical researches, and in that lies the future of foundry advancement.

A further important branch of the Association's work has been in raising the status of the craft to a level more in keeping with the skill involved in the work. The conditions under which foundry operations are conducted and the past lack of formulated scientific knowledge in regard to founding have placed the craft much lower in the engineering world than is really warranted. Like most crafts, founding can be conducted on highly technical and progressive lines or on slip-shod and purely empirical lines, and with the advance of scientific founding the prestige and standing of the craft is gradually rising.

It may not be out of place here, however, to remove any impression that the term scientific founding necessarily involves revolutionary methods and the elimination of the old practical craftsman. The scientific founder is he who applies existing knowledge to the efficient conduct of his work, and that knowledge may be the result of accumulated experience equally as well as the formulæ of the laboratory. In fact, beyond the application of certain physical laws which the chemist has explained, scientific founding chiefly consists of the intelligent conduct of all operations in the light of knowledge gained by past experience, either personal or imparted. The intricate requirements of modern engineering are so numerous that almost every new job presents a new problem, to the solution of which the laboratory can often contribute but little; and to say this is not to detract from the value of the latter's work. Briefly expressed, the scientific founder is a man of practical experience whose comprehension of scientific principles and physical laws is such that he can apply them in his every-day work; and it is such men that this Association is producing by its educational work. Is it strange, then, that it has the ardent support of all men who realise what an important part the foundry plays in engineering advancement?

It is hardly necessary to recapitulate the functions for which the Association was founded and the principles upon which its work is based; but I may say that there are still very many men who should be giving it support but who are not within its embrace. Why is this? Is it that the work of the Association does not appeal to them, and that they are so satisfied with their own methods of working that they do not desire to go across the way to see what the other fellow is doing? Or is it merely the result of that natural apathy to which frail humanity is so prone?

I can hardly believe that the average foundryman is really indifferent to higher education in his craft. He is a giant at his daily calling, but the work is so laborious and exhaustive that it leaves him with little energy to take up any scientific study out of working hours, even if the district in which he is located offers special facility. We are at present in what might be called a transition stage in this matter, passing from a period of total disregard to one of serious attention; and until the subject is placed upon a proper basis there will always be great difficulty in general foundry education. It is to be sincerely hoped that the near future will develop conditions under which all foundry workers, particularly the lads, will be able to take advantage of proper facilities for gaining knowledge of the higher aspects of the trade. They will then be better able to fit themselves for the increasing requirements of founding as a branch of engineering. In this direction again the Association is doing admirable work, and we may look with confidence to results which will tend to produce, not amateur scientists, but founders whose practice is based on high intelligence and scientific knowledge.

At the present moment, when there is so much room for broad educational work in the trade generally, the Association fills a gap which nothing else could. The opportunities it affords to members are beyond price—opportunities to correspond with each other on all matters affecting the daily routine work and the difficult problems which arise continually during foundry operations. There is no phase of foundry work upon which some light cannot be thrown by some member; for the Association embraces eminent metallurgists, chemists, expert moulders (engaged in all classes of work, including marine engines, hydraulic work, gas engines, pipe work of all kinds, stove work, and non-ferrous alloys), proprietors, managers, pattern makers, draughtsmen, cost-clerks, and all others concerned

with the trade. No matter on what subject a member may require advice or help, there is always some member who can supply it, as has been so well proven in the past. A perusal of the "Proceedings" of the Association will show the wide range of subjects discussed by competent authorities, and further there are the informal discussions which take place between members, and which are often productive of incalculable help.

Mention has been made of the value of scientific education in works practice, and I think you will all agree the need is more urgent now than ever. It is strikingly apparent in every foundry, for there is probably not a foundry in the world which produces a single week's work without defects of some sort. There is urgent need for more knowledge in the higher branches of the trade and the scientific principles which underlie its operations. Proper appreciation of these leads direct to better results. We all have the capacity for work, but what we want more than anything else is the knowledge of how to work without conflicting with natural physical laws. We all desire most earnestly to eliminate all trace of wasters. "Out of sight, out of mind" is a common adage in the foundry; but this attitude is entirely wrong, for we must always be ready to learn the lesson that wasters can teach if intelligently studied. The successes of to-day must not be allowed to entirely obliterate the failures of yesterday. As long as failures occur so also is there something to learn. Just consider for a moment a few of the causes of wasters:—Blowing, through the mould being too damp or gases being unable to escape; scabbing, through the sand being washed away by the stream of molten metal; run-outs, through insufficient weight on the mould or weak building in loam moulding; metal bursting through the top, by reason of the sand not being secured; castings poured short, too slowly, too hot, or too cold; parts dropping after closing of the mould; runners too small or too large; moulds rammed too soft or too hard; cores being washed away; cores not dried properly, or not vented; metal getting in vents; moulds crushed; the use of too much coal-dust in the facing sand; dirty runners; sand falling off lip of the ladle when pouring; gas-holes; draw-holes; sponginess; hard casting; weak castings, etc., etc.

The foregoing cites at random causes of wasters, some of which directly result from lack of practical training, while others undoubtedly indicate want of scientific knowledge. It will be clear, then, that the successful founder of the future is not to be found in either the purely rule-of-thumb practical man nor the man of scientific training only. No amount of schooling or laboratory work can ever produce a founder, for intimate contact and practical hard work with its trials and disappointments alone can give the breadth of vision necessary in the craft. Without systematic scientific training the practical man has often succeeded admirably in the past, because he has accumulated by experience a fund of really scientific knowledge, though he may not have called it such. But when practical skill and experience are supplemented by a systematised knowledge of physical laws, the experience of others may also be utilised. It is the function of proper foundry education to give the founder the experience of the past in such a manner that he may apply it intelligently in the present. When this becomes an accomplished fact we shall find the craft taking its proper place in engineering respected as a calling demanding high skill and intelligence. The motto of this Association. "Science hand in hand with labour," will then be not an ideal but a practical reality.

Mr. T. H. Firth, who proposed a vote of thanks to the President for his Address, said that the very thoughtful remarks contained in it were well worth careful perusal and study.

Mr. F. J. Cook seconded, and the vote of thanks was carried with acclamation.

The President proposed, and it was agreed to, that a vote of sympathy be sent to Mr. J. Smith, of South Shields, on the loss of his son at the front.

Mr. S. A. Gimson proposed a hearty vote of thanks to the late President, Mr. Mayer. The members had reason to be exceedingly grateful to him for the work he had done for the Association during his year of office. He did not believe there was in the Association a man who had the welfare of the Association more at heart than Mr. Mayer. He had visited all the branches during the year, and with all due respect to Mr. Ellis, he had wanted to see Mr. Mayer President for a second year.

The President, in seconding, said he himself had also wished that Mr. Mayer could have had a second year of office, but apparently it was not to be. He was delighted to second the vote of thanks because no one outside the Council knew the amount of time and work Mr. Mayer had put into the Association. Never was there a more enthusiastic President.

The members heartily responded to the resolution.

Mr. Mayer, replying, said that what had been spoken with regard to himself was just a little bit too flowery. He had been very proud to have been President, and what he had done had all been a labour of love.

Mr. R. Buchanan proposed that the usual honorarium of 40 guineas be voted to the secretary.

Mr. Gimson seconded, and the motion was carried.

The proceedings then terminated.

SPECIAL STEEL ALLOYS IN GERMANY.—A German report refers to the general meeting on May 27 of the Association of Makers of Special Steels, which was formed under the influence of the war and comprises twenty-two works. Among other matters the meeting discussed the question of the supply of raw materials, and the appropriate measures for guaranteeing the delivery of the necessary metal alloys during the continuance of the war. The fact was recalled that, as was reported a short time ago, several works had succeeded in manufacturing high-speed steel without tungsten. Other German works had since followed in the same direction and with similar success. In a similar way a number of the works had succeeded in manufacturing nickel-free alloys for constructional steel, army and naval purposes, motor cars, and aeroplanes, etc., which were of equal value to the nickel alloys previously used. The report further stated that as the war had shown the great importance of the possession of a strong and vital industry for producing special steels, every reason existed for the industry being given adequate Customs protection after the war, especially as the protection hitherto had merely been founded on the same basis as the duty on ordinary merchant bars.

The British Electrolytic Zinc Company (Isherwood Process), Limited, has just been registered with a nominal capital of £62,500 in £1 shares, to adopt an agreement with the Venture Trust, Limited, and to carry on the business of refiners of zinc and other ores, tailings and residues. The Refractory Zinc Ore Treatment Company have the right, so long as they hold 15,000 shares, to appoint two directors.

The Production of Patterns for Internal-Combustion Engines.

By Joseph G. Horner, A.M.I.Mech.E.

Manufacturing Methods.

This extensive subject should be regarded from the manufacturer's point of view, which is that of economical production consistent with the degree of accuracy desired. Everything is included in these throughout the whole range of the vast practice. They affect the pattern, and its moulding. The conditions which arise and which may conveniently be regarded as variables are numerous. They apply to all practice, regardless of the character of the metals or alloys employed, and may be grouped broadly as follows:—

(1) The numbers of castings required off. (2) Their dimensions and shapes. (3) The degree of accuracy desired. (4) The materials. (5) The question of the use of cores. (6) The methods of delivery. (7) The employment either of full patterns, or alternatively of sweeping up.

If we consider these variables attentively we shall perceive that each one is conditioned and radically controlled by some one or more of the others. Neither occupies an isolated place. The first two are the ones which naturally arise first in the mind of the patternmaker and foundry manager when about to settle the methods to be adopted.

All automobile work is manufactured in large quantities, which marks one extreme. Also the castings are all of small dimensions, likewise an extreme. But the larger oil engines of Diesel and marine types, and blast-furnace gas engines, occupy the other extreme, being not only large, but manufactured also in single orders, or else in very small numbers in one size. The methods suitable for the first are therefore wholly different from those which are applicable in the second. Many patterns for the first are made in metal, and a good many are either plate- or machine-moulded, while for the second the larger patterns are made in wood and moulded by hand, or in some cases loam patterns or loam moulds are employed, or again skeleton-like patterns and sweeps are adopted with a view to lessening the cost of material in patterns when wholly constructed of wood. Intermediate are many patterns usually built of wood alone, or else of a composite character comprising both wood and metal, the latter being conveniently employed for weak sections. But though patterns of metal are used in actual service these, in the majority of cases, have to be made from previous ones constructed of wood, which being required for a temporary purpose only are made without regard to fine accuracy or permanence of form. Other details have to be considered, as jointing, taper, delivery, and so on. Just now we confine our attention strictly to the points immediately concerned with numbers off, and dimensions.

Fig. 1.—A Bed for an Oil Engine.

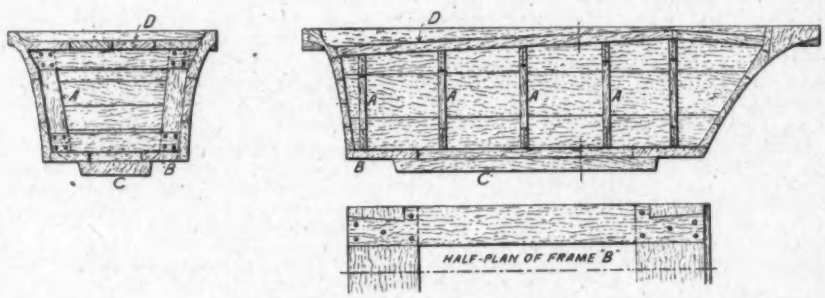


Fig. 2.—The Pattern for the Bed in Fig. 1.

Numbers Required Off.

These determine the methods of the patternmaker in the first place, but dimensions are in his mind at the same time. Numbers off have a vital bearing on the kind of construction adopted and on the materials used. But these again are also influenced by the sizes of the patterns, whether they are very small or very large, or just of average dimensions. At extremes one knows instinctively how to work, but many jobs occur which are on the border line and here alternatives present themselves.

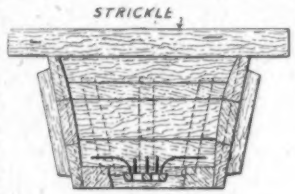
Patterns of Wood.

Obviously when a pattern is constructed of metal it is both strong and permanent, however attenuated its dimensions are. Also it will retain its size and shape unchanged in the damp sand and throughout lengthy service, even though many

thousands of moulds are taken from it. But a large pattern of wood, unless constructed by certain methods, will not remain unaffected, and if very thin and flimsy it will not even retain its shape during the period of a single ramming up in sand. In any case, with increase in the numbers of castings required, the need for metal patterns becomes more imperative. And even where these are not used, such as in many articles of medium dimensions and in those on the border lines, methods are adopted by means of which the reasonable permanence of wood patterns is secured, and by which they are enabled to endure many hundreds of mouldings without suffering any material loss of their first accuracy. These have as their basis first the employment of sound, well seasoned and suitable timber.

Materials for Patterns.

The development of the automobile has caused the demands made on the patternmaker and moulder to become more exacting than they are in ordinary small engine and pump work. Thicknesses are reduced with the double object of keeping down weight and of securing rapid cooling when in service; and since most of the work is cored this entails more careful cutting of patterns and core boxes in order to ensure such exact correspondences that the thicknesses will be neither less nor more than wanted At the same time more care has to be exercised in the selection of suitable materials, which will be both durable, and retain permanence of form. Yellow pine, an admirable wood for all the ordinary work of the pattern shop, is not hard enough for prolonged service on small patterns. It is suitable for large patterns and core boxes, as the cylinder bodies of gas engines, the beds and flywheels, and if properly constructed and well varnished gives little trouble by warping or shrinkage. But for the smaller patterns and boxes, and for the more



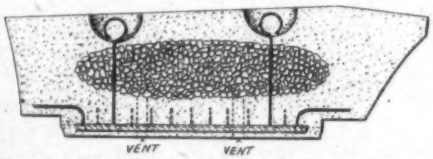


FIG. 4.—THE CORE MADE FROM BOX IN FIG. 3.

delicate portions of larger ones made in pine, the baywood is better than any other. It is not a true mahogany, though it much resembles it in appearance. It is softer and straighter in the grain, easier to work, and is not quite so liable to warp as mahogany, these being recommendations from the patternmaker's point of view. Cherry wood is a fair material, rather harder than mahogany, and it takes a fine smooth finish. Other woods need not be discussed, as they are seldom used, unless we except the American whitewood, which is a good substitute for the others, provided it is thoroughly seasoned. Patterns made of these woods, if well protected with shellac varnish, renewed at intervals, will last long and preserve their accuracy through some hundreds of mouldings—four or five hundred often.

Construction Methods.

But the selection of the best timbers alone will not ensure permanence, which can only be secured by constructional devices, as open joints, halvings, laggings, and segmental work. In each the object sought is to localise and minimise the injurious action of moisture and of warmth upon the timber, and often, also, to render the several pieces mutually coercive. Some of these are illustrated by the examples of patterns shown. They have their applications respectively in plated work, in cylindrical, and in circular articles. In each the possible shrinkage or expansion is limited to the width of the narrow piece, strip, or segment. No large area or depth is ever made solidly. It would not retain its shape for even a short period. The principles embodied in the illustrations are adapted and modified in very many ways to suit patterns of different kinds, details of cutting and building up, which, though of interest to the

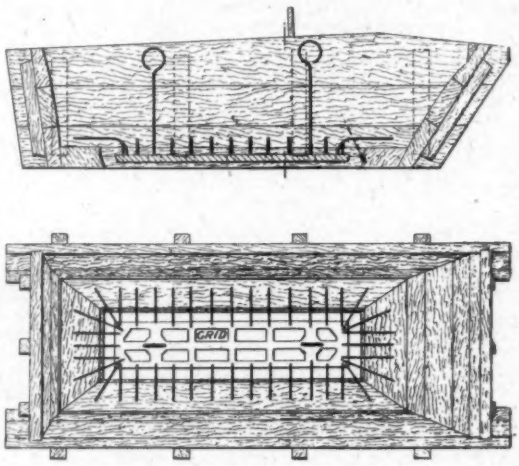


FIG. 3.—THE CORE BOX FOR THE BED IN FIG. 1, WITH ITS GRID.

craftsman, do not concern us here, where the broad methods only are stated. But, as already emphasisted, the limit to patterns of wood comes with work which is being constantly repeated. When the number of moulds totals to thousands, metal must be employed, iron, brass, aluminium, or white metals; iron for the larger, the others for the smaller patterns.

Oil-Engine Bed.

An example of a bed which illustrates several facts is shown in Fig. 1. In the first place it must be cored. The reason why self-delivery is not practicable (we never say impossible) is the presence of the wide return flanges on the top—the bottom as the mould is made—and the curved sides and ends which do not admit of constructing a strong uncored pattern similar to its casting. The way to make the pattern, therefore, is that shown in Fig. 2. It is an example of boxing-up. The sides are formed of narrow strips screwed on cross frames A, located at intervals of 10 in. or 12 in., or sufficiently near to each other to afford adequate support to the strips which are screwed on them. They are framed, in preference to making them of wide board, in order to avoid risk

of shrinkage. The sides are laid on in narrow strips for the same reason, and the joints are not glued, and are better if left 1/32 in. open. The ends are nailed to the sides. The bottom of the pattern (top of the casting) is made also of narrow strips framed together, B, leaving an open space which is covered by the print, C. The top, D, of the pattern is formed by screwing narrow strips down on the cross bars, A.

The core box, Fig. 3, is made of sides and ends, with internal flanges to correspond with the print and the metal around the top of the casting. The top edges of the box correspond with the cambered inside of the bed where the waste oil drains to the pet cock. A strickle imparts the outline of these edges to the core. The construction of the box sides is that of strips screwed to cross battens or cleats, to minimise shrinkage, as in the pattern. The ends are rebated into the sides, and held during the ramming of the core, either with screws or clamps, which when removed permit the sides and ends to be drawn away from the core, leaving it standing on its plate. The core is carried on a plain grid the outlines of which are shown, having eyes to lift and lower it with and rods to carry the sand over the flanges. The core is seen in section in Fig. 4. The holes seen, left for lifting the eyes, are filled up after the core has been lowered. The vents from the core pass down into the bottom. In large cores like this the central portion is formed of cinders, in which the air from the vents made by the wire collects quickly, and whence it is taken away outside the mould. In a mould of this kind it is usual to lay a cinder bed beneath the mould, from 6 in. to 1 ft. below the bottom face of the casting, into which the air which passes downwards collects, and is thence led away to the outside through diagonal vent pipes.

A Gas-Engine Cylinder.

Few castings have a greater variety of forms than cylinders. And a few apparently slight differences in details will sometimes radically influence the methods of making the pattern, and of moulding and casting it. We thought some of the old steam cylinders presented very difficult and intricate problems, notably the Corliss, the high- and low-pressure cylinders, with their valve chests and steam passages. But greater difficulties and increased intricacies have to be faced in many of those for oil and gas engines. The greatest risks centre in the coring. The character of the coring, too, often determines the method of jointing, whether it is to be done longitudinally or transversely, and whether two-part or middle-part boxes are to be used. Coring is especially risky in cylinder work, because the assistance of chaplet nails can only be utilised in positions situated away from bores, and often also from places where the metal is very thin.

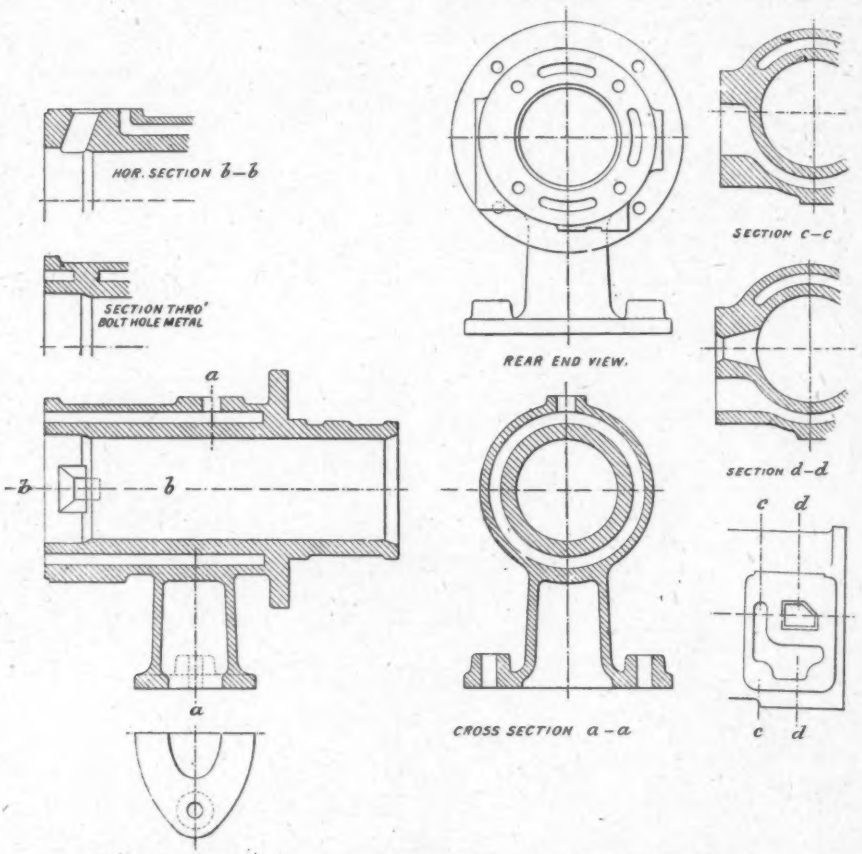


FIG. 5.—CYLINDER OF GAS ENGINE CAST WITH JACKET AND FOOT.

An example of a cylinder with fewer complications than many is given in Fig. 5, that for a gas engine having its jacket cast in one piece with the cylinder, a flange by which it is bolted to the bearing casting, and a foot to bolt it to the casting of the base.

Such a cylinder is preferably molded as it lies in the plane of the paper. It would be much better moulded vertically if the jacket core alone could be regarded, using then an annular print in the bottom for that core. But that would entail the use of a middle-part box with joints through the centre of the foot, and along one face of the flange. Some might prefer to adopt that method. Here we assume that the jointing is done longitudinally.

The next matter to determine is the way to make the pattern. If of large dimensions the body would be swept in loam on a bar (Fig. 6) against the edge of a board. Then the flange, the foot, and the small bosses are made in wood, and laid against the loam in the mould.

Sweeping a Pattern in Loam.

When a cylinder body is swept up this is done on trestles on which the board is supported, and in the tees of which the spindle is rotated. The profile of the pattern is cut on the working edge of the board. Its radius is set from the centre of the bar. The loam is plastered on hay bands which are wound round the bar. If the diameter is much larger than that of the bar, as it is in the example, support is afforded to the bands with thin iron plates slid along it (seen in the broken section), and wedged at intervals. Though the loam is hard enough when dried to sustain without yielding the pressure of the rammed sand of the mould, it is yet too fragile to permit of thin sections, such as flanges, being rammed against. These, therefore, when required are fitted in wood on the loam. Also all parts which cannot be swept, as brackets, lugs or like sections, have to be made in wood and fitted to the loam precisely as they are fitted to the wood body in Fig. 7. Practically, then, the only portion here which can be swept is the main body. But as this is the part of the pattern which is most expensive to construct in wood the economy is very substantial. Made in wood (Fig. 7), it must be lagged, which absorbs a considerable quantity of timber and occupies much time in lagging, besides that of the turning. The cost of the sweeping board is trivial, and the time occupied by the coremaker in sweeping two coats is measured by, say, two or three hours; so that the saving is important. But it affords one of those alternatives which are on the border line, the principal factor in which is either dimensions or the quantity of separate wooden fittings required. A rather small pattern with a lot of fittings should be made wholly in wood; a large one with few fittings, in loam. Any pattern, whether large or small, simple or elaborated, if required for repetition work must be made wholly in wood, or in some cases in metal.

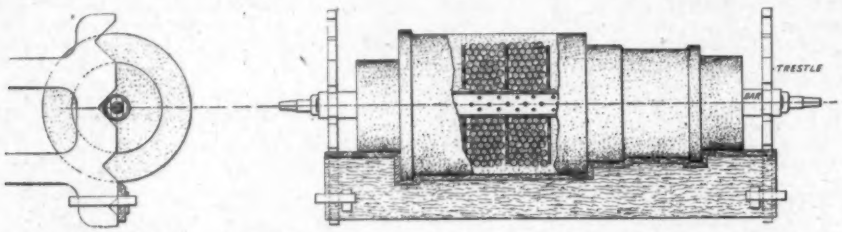


FIG. 6.—SWEEPING A LOAM PATTERN FOR BODY OF CYLINDER.

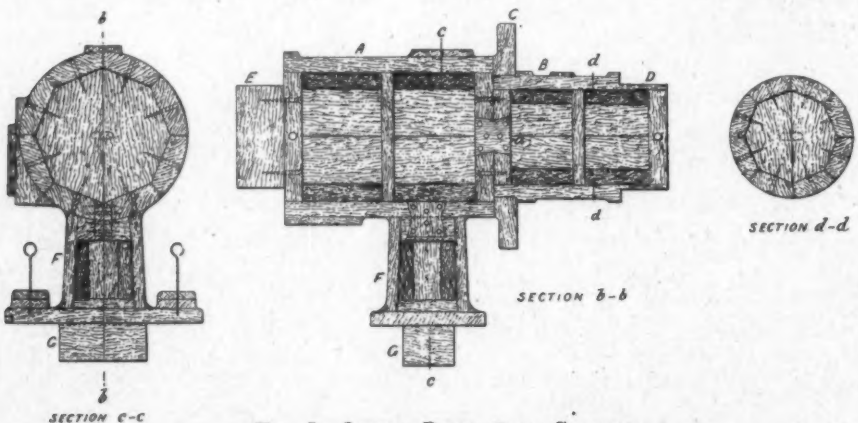


FIG. 7.—LAGGED PATTERN FOR CYLINDER.

A Lagged Pattern.

For a small pattern, then, or for one of medium dimensions the entire pattern is made in wood, the body with lags, the other portions as shown in Fig. 7. As the jacketed portion A is much larger than the other piece B in front, if the lagging is made continuous it will be very thick around the jacketed body, so thick, in fact, that it will be liable to shrink and become rather distorted, to say nothing of the waste of timber. The body is, therefore, in this case made in two separate lengths united with a dovetail, and glued and screwed, (see

the detail at *a*), and then turned as one piece. The flange C fits into a recess turned in the body, which recessing ensures the accuracy of its position, while making it separately avoids short grain. Two methods of fitting the end prints are shown. In one, D, to the right, the print is in one with the lagging because there is no great difference in the diameters of print and body. But at the left, E, to make it continuous would entail cutting the lagging much too thick. It is attached, therefore, separately with screws to the end cross-bar.

The reason why solid stuff is not suitable for any

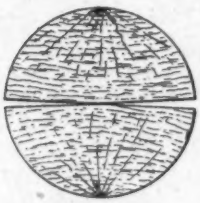


FIG. 8.—SHOWING HOW SOLID STUFF WARPS AND CURVES.

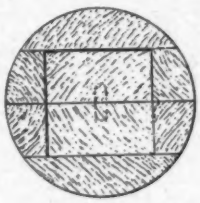


FIG. 9.—A CHEAP METHOD OF CONSTRUCTION.

cylindrical pattern of over 4 in. or 5 in. in diameter is obvious to anyone who knows how timber warps. In Fig. 8 the annular layers or rings will shrink towards the centre, and the joint faces will become convex, as shown. If the joint faces occur near the centre of the tree they will become concave. In neither case will the circular form be retained, and if the joints are corrected by planing that will impair the circular section still more seriously. The only alternative, then, to lagging cylindrical articles, and one which is adopted in the cheaper kinds of patterns, is that shown in Fig. 9. On cross-bars at each end three longitudinals are glued and screwed, and glued to each other. This is much better than Fig. 8, but not nearly so good as lags. All the central portion is removed, but the principal pieces are still nearly as wide as the diameter, and therefore very sensitive to the effects of moisture and warmth.

The foot F (Fig. 7) is made as a separate piece, and united to the body with a dovetail, in addition to which screws are inserted from within the lagging. A rather long print, G, is put on to carry the core; the bolt bosses are skewered on loosely in two thicknesses. No cores are inserted in these; it is safer to drill the holes in the solid.

The presence of this foot determines the direction of jointing, which is done through it at *b*, *b*, as involving less trouble than jointing in the direction at right angles, which would bring the foot in top or bottom, with another joint across its face. No other observations need be made on the pattern.

The Jacket Core.

Only one item in the work of moulding this cylinder is troublesome and actually risky, and that concerns the jacket core. It is difficult both to make and to fix. Yet in some form or another it occurs in all gas- and oil-engine cylinder castings, those of large dimensions alone excepted, in which the liners are cast separately from their casings, and in the ribbed designs of cylinders. This core and the method of setting it is shown in the drawings of the mould (Figs. 10 and 11), the box in which it is made (in Fig. 12) and the core separately (in Fig. 13).

The difficulties and risks lie partly in the slender section of the core, partly in its setting in the mould, the first being the greater. It is so thin that some prefer to make it of self-binding sand and use no grid. Then with a sand mixture of close, hard texture there is likely to be trouble with the vents. In a case like this where withdrawal from the casting offers no special difficulty, it is better to make a grid of crossing wires soldered together, which can be pulled apart and got out easily with pincers. That is not practicable in cores where the grid cannot be withdrawn, in which case self-binding core sands must be used.

With regard to vents, these can only be brought out at the open end, nowhere else. As the area of the core is large, the gases generated form a con-

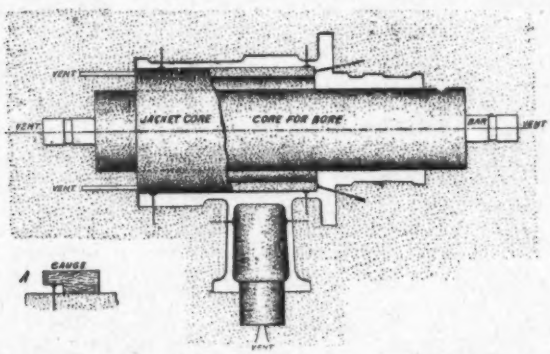


FIG. 10.—PLAN OF CORED MOULD FOR JACKETED CYLINDER.

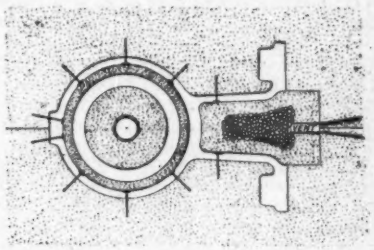


FIG. 11.—CROSS SECTION THROUGH CORED MOULD FOR JACKETED CYLINDER.

siderable volume, provision for the escape of which must be made. The way to make this is to ram slender rods longitudinally at intervals, and withdraw them after the core has been made and before it is dried. Another is to ram common strings or waxed strings, or the common wax tapers, in the sand, which will melt and burn out when the core is dried. These are disposed longitudinally or circularly, as seems best, or in both directions. But care must be taken to see that they do not cut through to the outsides of the core. If they do so, and the fault is not repaired, the metal will get into the core and blow the casting. The core vents are brought outside the mould through small pipes of gas tube rammed in the core (Figs. 10 and 13). Two will usually suffice, as the air will find its way to the channels of least resistance.

The water outlet, it will be noticed in Fig. 5, comes out against the same face as the gas inlet. This is more safely made in one with the jacket core than as a separate core, and provision is accordingly made in the box (Fig. 12) for its formation. It enters into print impressions provided on that side of the pattern (Fig. 7, left hand). The outline of the print is that of the opening seen at the right hand of the group in Fig. 5. There is also metal bridging the jacket core at three places, seen in the rear end view in Fig. 5, and in the horizontal section through the bolt-hole metal in the same illustration. The positions of these pieces of metal are occupied by similar blocks of wood fitted in the core box (Fig. 12). The core has the appearance shown in Fig. 13.

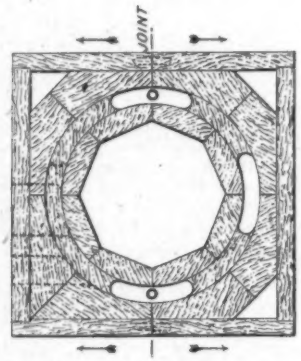


FIG. 12.—BOX FOR JACKET CORE.

The cores are inserted as follows:—The core for the gas inlet (seen in Fig. 5), being prepared from a box, not illustrated as it is quite plain, is, with the other cores, all dried and blackened, brought alongside the open mould, also finished. The jacket core is first inserted and set by its outlet print and by the chaplets, to be noted directly. Then the gas inlet core is thrust into its print impression through the opening which provides the metal round it in the jacket core. Then the cylindrical core for the bore is slid along through the jacket core and laid in its print impressions. Finally, the core which lightens the foot is inserted. When the top box part is lowered, that secures the cores for the bore and for the foot,

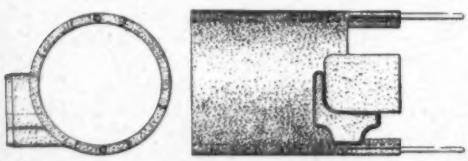


FIG. 13.—JACKETED CORE FROM BOX IN FIG. 13.

so that they cannot be pushed out of place by the pressure of the inflowing metal, but, in the absence of such aids, the jacket core has to be secured with chaplet nails.

The Use of Chaplet Nails.

The setting of the jacket core is done by the chaplet nails seen in Figs. 10 and 11. These are always used as sparingly as possible in moulds, because they are liable to generate gases when the molten iron comes into contact with them, and produce either general sponginess or blow-holes in the vicinity. In no case would their employment be permissible against a cylinder bore. They may be used as shown against the liner core, passing as they do only through the outer metal.

Chaplet nails are tinned to lessen risk of the formation of gas. They are thrust into the sand, the friction of which is sufficient to retain them in place in this case. But when they have to sustain heavy cores they are supported either in blocks of wood buried in the sand, or against plates of iron. They are set by means of a gauge (Fig. 10), A, the depth of shoulder of which exactly corresponds with the thickness of metal. The disposition of the chaplets in end view is shown by Fig. 11.

Another illustration of the use of chaplet nails occurs in the core that lightens the foot (Figs. 10 and 11). The main print impression carries it, and the chaplets prevent it from being shifted up or down at the end away from the print.

It will be observed that some small holes are not cored. They rarely are in work of this kind. It is better to drill such holes. Some other details on which no observations are offered will be noticed.

CORE-BAKING FOR MOTOR-CAR WORK.—In the larger motor-car casting foundries many intricate cores have to be handled every day. In some cases part or all of the mould is made of dry sand in the form of a core, and these rammed-up cores increase the work in the core department. A new core room has recently been laid out and put into service at the plant of the Wilson Foundry & Machine Company, Pontiac, Michigan, U.S.A., which is making the entire output of grey-iron castings required by the large plant of the Willys-Overland Company at Toledo, Ohio. The majority of the cores in this foundry are baked in rack-type ovens. There are ten ovens in each battery, arranged in two groups of five, each placed back to back. An electric-lift truck introduces the racks into the oven. Each oven is made of sufficient size to accommodate two racks. In practice these racks are set down next to the core maker's bench, and the core maker puts the green cores upon the rack. The truck then picks up the rack and places it in the oven, where the cores are baked. After baking, the racks of hot cores are withdrawn and set on the cooling floor, and other racks are substituted for them. The ovens are always kept closed whether empty or full, to conserve heat, the doors being opened only at the time cores are being placed in or removed from the oven. The fire boxes are all sunk beneath the regular foundry floor, and the firing pits are entered through ladderways. The entire fire pit is under air pressure, and dampers are provided for controlling both the forced draught in the fire pit and the auxiliary air. The doors are insulated with cellular insulating material, are counter balanced, and provided with locking cams, which hold them in place when closed. In these ovens the heat enters at the back, and is taken out through dampers at the front. Among the advantages claimed for having the fire box below the floor is that the only interference with regular foundry operations arises from the fact that there must be a manhole through which coke can be dumped into the coke bin and a ladderway for reaching the pit; all the rest of the foundry space is available. Ovens of this type have been in use for more than two years, and have proved their success. The racks are arranged so they can be picked up by a trolley and taken to the foundry as required. Practically all of the storage of cores in the Wilson Foundry is on racks. This system has been found to be more flexible than the installation of permanent shelving and also does away with the handling of cores. The core is placed in position by the core maker and is not removed until it is to be inspected and sent to the foundry, or until it is required by the man pasting up groups of cores.

Oil-Fuel Possibilities.

Liquid fuel or fuel oil has been much discussed in the past, and its advantages and disadvantages have been reviewed by different writers, many of whom have openly set out to prove a case either for or against its general adoption. At the same time, the fact that oil fuel has found increasing favour in some directions is an indication that under some conditions it has a legitimate field of application. There are certain obvious advantages in the use of such a fuel, as compared with coal and coke, which persist under all conditions, though they may be outweighed ultimately by such considerations as price and availability of supply. Under present conditions, however, when the price of coke is higher than all normal records, the possibilities of alternative fuels should be carefully considered. We may, therefore, review again the question of oil-fuel in the light of present-day coke prices and the advantages and disadvantages of each class of fuel.

The oil-fuel which comes within the range of the founder, it is well known, is a product of petroleum refining. Petroleum production has increased enormously during recent years, and practically doubled in the years 1902-1912. The distribution of the resources is wide, but we may take for present consideration Mexican oil, since about half of Great Britain's total imports in 1913 were from Mexico*

Petroleum products for power purposes may be broadly divided into three classes:—(1) Petrol for internal combustion engines, such as used on motor-cars, air-craft, etc.; (2) refined oil (paraffin or kerosene) used for internal combustion engines, heating, etc.; (3) fuel oil, used in steam raising, heating and similar purposes. It is the latter class of oil with which we are at the moment concerned; and it may be well here to draw attention to the misapplication of the term "crude oil," to designate fuel oil, since the crude oil contains the petrol and kerosene which are removed by distillation before the fuel oil is produced.

Mexican fuel oil is a heavy, dark-coloured product, usually more viscous than the crude oil, and having a specific gravity of about 0.950 at 60 deg. F. Its flash point is above 150 deg. F., and its viscosity at 100 deg. F. (Redwood No. 1) is 1,500 seconds. Its calorific value is given as 18,900 B. Th. Us. per pound, or 10,500 calories per kilogram. A typical analysis is as follows:—

	Per cent.
Carbon	83.52
Hydrogen	11.68
Sulphur	3.27
Ash	0.16
Undetermined (presumably oxygen and nitrogen)	1.37

The above sulphur content may appear high, but since the sulphur, as such, does not come into contact with the metal in ordinary foundry use of fuel oil, the chief objection would appear to be in its low calorific value (4,500 B. Th. U. per lb.). When crucible furnaces are used the sulphur content is not so important as with hearth furnaces in which the flame has direct contact with the metal.

Apart from the question of price, Mexican fuel oil possesses certain outstanding advantages over coke. First, its calorific value per lb. is high. Its regulation is easy and a perfect combustion can readily be obtained; while a reducing atmosphere can be maintained without any trouble if necessary. Owing to its ease of regulation and contro of combustion, also, a much higher efficiency can generally be obtained than with coke, whose texture and composition considerably affects the conditions best suited for its proper combustion. The heating value of fuel oil, moreover, remains practically constant, while that of coke varies considerably according to the nature of the coal from which it is made and the conditions of coking. In the matter of storage fuel oil has a distinct advantage, in that it requires less space; and it involves less handling, thus reducing the labour necessary. An oil-fired furnace requires very little attention, and the operation of heating can be started and stopped rapidly, eliminating waste.

An important consideration in melting non-ferrous alloys is the rate at which melting takes place. Apart from the actual fuel consumption, many alloys are spoiled by being kept in the furnace too long in order to attain the desired pouring temperatures. Particularly is this the case with the nickel alloys, but copper alloys also suffer much from the same cause. The longer the metal is in the furnace the greater is its opportunity to absorb gases and become deteriorated. It is generally understood by good founders how detrimental is the effect of allowing an alloy to "soak" in the furnace after melting; but is not so well appreciated that a similar effect is produced by melting too slowly. This is a strong point in favour of using first-class fuel, whether coke or oil, and the possibility of rapidly attaining high melting temperatures with fuel oil is a feature of great importance in foundry work.

Rapid melting in coke-fired furnaces also, of course, can be obtained by using forced draught, and since fuel oil requires the latter in its application to furnace work this feature is not exclusively its own. But certainly in the speedy attainment of high temperatures and the maintenance of the same with little trouble, fuel oil is superior to solid fuel.

Many of the difficulties of oil fuel applications in the past have centred on the spraying or "atomising" apparatus or burner employed; for an essential feature of successful work is the breaking up of the oil into fine particles and its intimate contact with the blast. Some designs of burners, also, involve fine valves and adjustments which, at times, tend to clog or choke, temporarily placing the furnace out of commission. But there are quite efficient burners suitable for furnace work which give no trouble in the direction mentioned. The systems of oil-fuel burners in use are numerous and need not be reviewed at the moment, as it is sufficient for the purpose to state that efficient burners are obtainable.

The advantages claimed for fuel oil for metallurgical work are briefly as follows:—(1) Increased output of plant; (2) reduction in cost of fuel required for a given amount of work; (3) saving in time taken by the operator and consequent reduction in labour cost; (4) more uniform results; (5) less waste owing to imperfect work, breakage, loss of metal, etc.; (6) possibility of running individual heats and shutting down the furnace without waste of fuel; (7) absence of ashes and necessity for daily cleaning of the furnace; (8) prolonged life of crucibles; (9) less floor space

* Much interesting data on Mexican fuel oil is contained in a book issued by the Anglo-Mexican Petroleum Products Co., Ltd., from which some of the following facts are abstracted.

required and cleaner condition of the foundry. With a suitable burner a temperature of over 3,000 deg. F. (1,700 deg. C.) can be obtained and maintained. It is also claimed that the quality of the metal melted is higher than when coke is used; but care must be taken not to so increase the air supply, in the endeavour to get maximum efficiency, as to create an oxidising atmosphere, or the metal may be damaged. The ease of regulation of the fuel supply, however, enables an intelligent worker to avoid this trouble, and the temperature itself can be regulated to within about 25 deg. F. The rapidity with which a high heat can be obtained certainly should aid in getting better metal than in slow melting, while rapid heating and high temperature are important features in fuel economy.

As regards the increased life of the furnace linings and crucibles, which is said to accompany the use of fuel oil, one American user of fuel oil states that in melting brass he has been able to obtain 43 heats from a No. 150 graphite crucible running four heats per day and with an oil consumption of about 2 gallons to 100 lbs. of metal. At one time he made 40,000 castings weighing about ¾ lb. each and which were finished on the inside and outside, the loss on this order being less than one per cent. His average loss is given as less than two per cent., and all the castings made are finished.

Coming now to a comparison of costs, the following figures represent results obtained by Messrs. Holman Bros., Camborne, using a Bickford crucible furnace for melting 40 lbs. of machine brass:—

	d.
Coke—	
½ cwt. oven coke at 1s. 3d.	3.75
3½ per cent. waste of brass	8.4
Crucibles (20 charges at 5s. per crucible)	3.0
	15.15
Oil—	
¾ gallon oil at 2½d.	2.0
1½ per cent. waste of brass	3.6
Crucibles (30 charges at 5s. per crucible)	2.0
	7.6

Even were the waste of metal the same, the above figures indicate a distinct saving in cost by the use of fuel oil.

Necessity for Annealing Steel Castings.

The question of whether or not it is necessary to anneal steel castings is frequently discussed, particularly when a new process to eliminate annealing is put forward, as occurs from time to time. But when castings are required to stand considerable stresses and shock, the necessity for annealing cannot be denied. There are, of course, many castings which do not come within that category, but that fact does not affect the contention. In this connection it is interesting to recall the experiments of Dr. P. Oberhoffer, of Breslau, recently reproduced in "The Iron Age," from "Stahl und Eisen." The composition of some of the steels worked on, arranged according to carbon percentage, was as follows:—

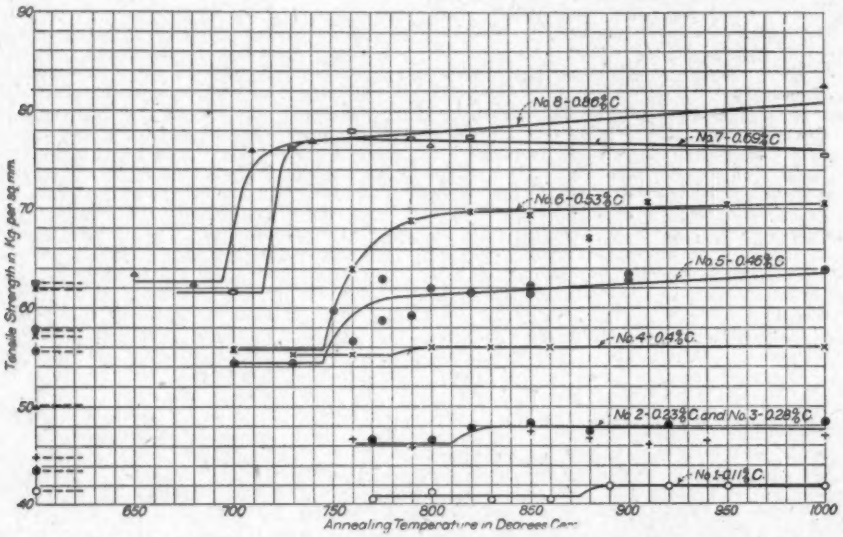


FIG. 1.—DEPENDENCE OF TENSILE STRENGTH ON ANNEALING TEMPERATURE.

No.	Carbon. Per cent.	Manganese. Per cent.	Sulphur. Per cent.	Phosphorus Per cent.	Silicon. Per cent.
1 ...	0.11	0.60	0.035	0.030	0.40
2 ...	0.23	0.98	0.038	0.042	0.38
3 ...	0.26	0.80	0.030	0.024	0.25
4 ...	0.40	1.11	0.039	0.027	0.21
5 ...	0.46	0.92	0.042	0.041	0.20
6 ...	0.53	0.79	0.036	0.027	0.25
7 ...	0.69	1.03	0.022	0.021	0.25
8 ...	0.86	0.90	0 028	0.016	0.27
1-A ...	0.13	0.96	0.067	0.072	0.36
1-B ...	0.13	0.43	0.029	0.035	0.52

These steels were cast in blocks 250 by 250 by 600 mm. (9.84 by 9.84 by 23.62 in.). They were all free from visible blow holes or contraction cavities, nor could any considerable amount of segregation be determined. Test pieces were cut out cold and the steel thoroughly examined, both as cast and after annealing for six hours at the desired temperatures and cooling slowly.

The average values of the results of the various tests are shown in diagrams given herewith, Fig. 1 showing the dependence of the tensile strength on the annealing temperature. Fig. 2 shows the dependence of the elongation on the annealing temperature, measured in 200 mm. (7.88 in.), and Fig. 3 results of shock tests. This last diagram

shows the great value of the shock test in testing steel castings, especially those with the lower carbon percentages, and all show the great influence of annealing at the proper temperature. A comparison of the different curves shows the amount of improvement, which varies from one material to another.

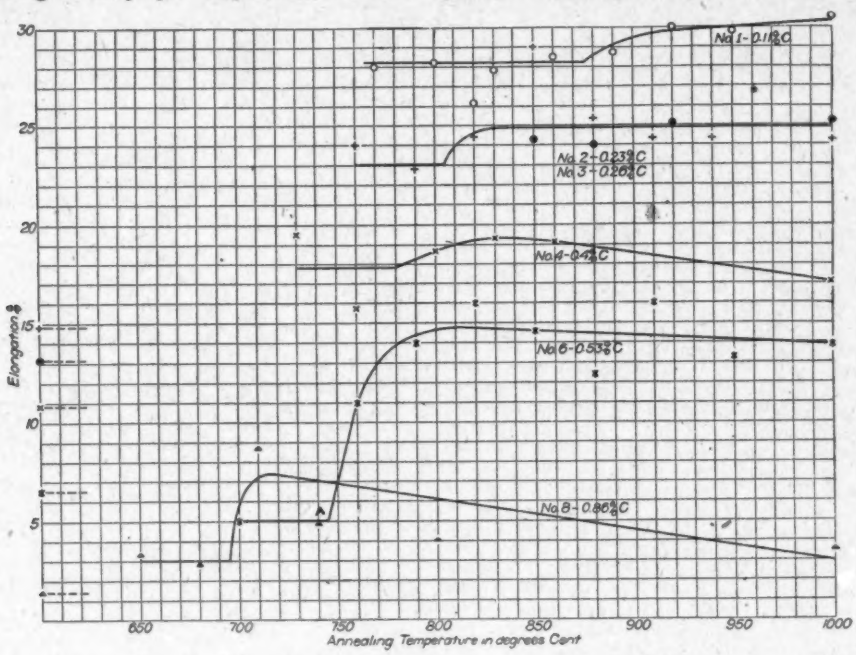


FIG. 2.—DEPENDENCE OF ELONGATION ON ANNEALING TEMPERATURE.

A practical method often used for determining the success of annealing is the observation of the tensile test fracture. A fine structure shows with certainty that the proper temperature has been reached. Unfortunately this method is not always of value, especially with the lower carbons where the elongation and reduction of area are higher. In such steels unannealed samples often give very good elongation and reduction of area. There is, however, another simple method to indicate whether the proper temperature has been reached. A rough surface of the test bar is clear evidence that it has been annealed below the proper temperature. This appearance is less noticeable the lower the elongation and reduction of area, but in these cases the fracture is more crystalline, so that either fracture or the appearance of the surface will give a certain indication as to the annealing, especially with soft steels, when a microscope is not available.

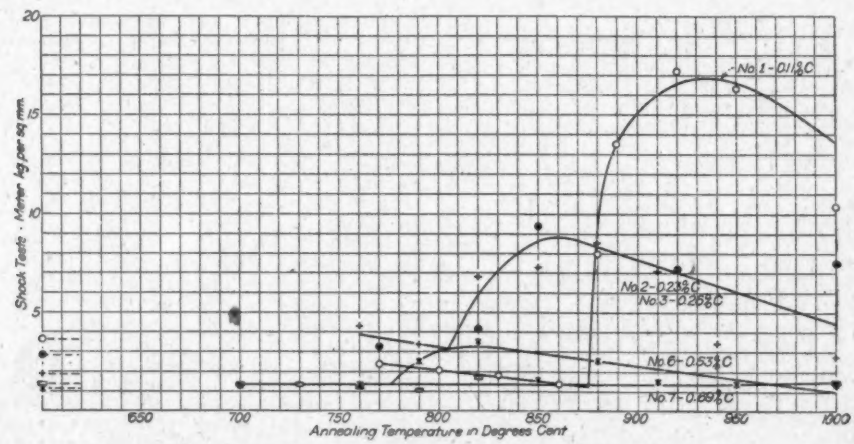


FIG. 3.—RESULTS OF SHOCK TESTS ON STEEL CASTINGS.

It should be remembered that exceeding the best annealing temperatures by a small amount, say 50 deg., is less harmful than the bad results caused by not reaching the proper temperature.

Theory of the Corrosion of Steel.*

By Leslie Aitchison, M.Met., B.Sc.

The complete structure of steels, composed as they are almost invariably of carbides embedded in a matrix of some carbon-free material, renders it almost certain that the action going on in a steel during its corrosion is a galvanic one. The large number of galvanic couples present in an ordinary sample of steel can be well imagined, and these couples will consist of the carbide on the one hand, and the ferrite or solid solution on the other. This postulates at once that one of the two constituents will be anodic in its action, and the other cathodic. The anodic one will be attacked by the solution—that is, the material composing the anode will pass from the atomic to the ionic condition. The other material, acting as the cathode, will remain in the atomic (or molecular) condition, and hence will appear to be unattacked. The intensity of the galvanic action between the two constituents will depend, other things being equal, upon the potential difference between the two consituents with respect to the corrosive liquid which is in contact with the steel. The carbides in all steels, although of varying chemical composition, will be likely to be possessed of very similar electrical properties, and hence it appears reasonable to assume that the electrolytic solution pressure of all the carbides will be the same, or nearly so. On the other hand, the solid solution, which may range from practically pure iron to an alloy containing many percents. of a second element, will be a material of very varying electrical properties. As a result the electrolytic solution pressure of this constituent will change very considerably from steel to steel, and will in consequence produce a considerable variation in the potential difference existing between the constituents of the steel. As a result the corrosion of the steel should vary a great deal with changes of composition.

All investigators have agreed up to the present in regarding the carbides as being electro-negative (that is, as having positive electro-affinity, or a greater tendency to exist in the molecular than the ionic form). Hence their action should be cathodic, and they should not be attacked by the corrosive liquids. That this is so may be seen by microscopic examination.

A similar result is obtained by an investigation of the attack of dilute acid upon various steels. By an analysis of the material which goes into solution, and a comparison of this with the compositions of the carbides separated by other methods, it will be found that the carbides are not attacked, and are left in their original form.

As a result of this the carbides in steel may be regarded as acting in two different directions. First of all, they act as resisters of corrosion. Since they are not attacked by the corrosive liquids, there should be a smaller loss in a steel which is composed largely of carbide than in one which contains only a moderate amount of that constituent. This may be, and probably would be, true were it not for the other action of the carbides. This is connected with their cathodic action. The intensity of the galvanic action will be to some extent proportional to the area of contact between the two constituents. The more finely divided the carbides, the greater will be the area of the surface of contact; and also the larger the quantity of carbide, the greater the available number of surfaces of action. That this is true may be seen from the figures in Table I. The first pair of results demonstrate the second action, of increasing the carbide, whilst the remaining ones show the first action—that is, of increasing the fineness or the state of division of the carbide. This latter is the normal result of the addition of small proportions of a third element (that is, one besides iron and carbon) to steel.

TABLE I.

Carbon per cent.	Other element per cent.	Loss of weight in		
		3 per cent. sodium chloride solution.	Tap-water.	10 per cent sulphuric acid.
0.50	—	0.992	0.88	4.57
0.89	—	1.196	0.92	10.82
0.74	W 2.36	1.54	0.97	8.42
0.73	Co. 2.68	1.55	0.94	5.12
0.63	V 0.71	1.73	0.90	8.05

These three pieces of evidence—the microscopic, the analytical by sulphuric acid, and the effect upon the corrosion—may be taken as conclusive in proving that the carbides act throughout as cathodes. The rest of the material then becomes the anode in the various galvanic couples present in the material. As stated above, this residue of the steel is practically always solid solution. In the case of ferrite, the solution is extremely dilute, sufficiently so for the ferrite to be termed pure iron, whilst in other cases there may be as much as 12 or 15 per cent. of a second element.

Considering the ferrite alone, two cases arise. First of all there is the common one, in which the ferrite is present in contact with some carbide and acts as the anode in a galvanic couple. This case is perfectly simple, the action coming about in consequence of the solution pressure of the iron (the electro-affinity of iron, *i.e.* the potential of the metal against a normal ionic solution of its own ions, is—0.063 volt., iron being one of the metals which have a greater tendency to exist in the ionic than in the atomic condition). The negative electro-affinity in the case of the iron, and the positive (assumed) in the case of the carbide, produce all the essentials for galvanic action.

The other case is that of a relatively pure metal —*e.g.* bar iron—in which practically the whole of the material is composed of crystals of ferrite. As is well known, this material does corrode, and fairly rapidly too. The corrosion on the part of the ferrite in this case has been explained by the galvanic theory, on the assumption that the various grains of the metal have somewhat different solution pressures in consequence of the variation in the orientation of the different crystals. Also the presence of different degrees of mechanical strain in the various crystals is invoked as an explanation of this difference in the solution pressure. It appears possible, however, that neither of these explanations is necessary, in view of the more accurate knowledge that we possess of the structure of pure metals.

* Abstract of Paper read before the Iron and Steel Institute.

Many workers have demonstrated the existence of amorphous material in between the crystals of a metal, which has properties quite different from those of the adjacent crystals. Amongst other things, it has been made very probably true that an amorphous substance is possessed of a very different solution pressure from that of the crystalline substance. It has been definitely established frequently that a worked material has a much greater solution pressure than an unworked one; and as the amorphous layer in between the crystals has a relatively close similarity to a worked material, it is not unreasonable to imagine that the solution pressure of this layer is greater than that of the adjacent crystals. Whichever phase has the greater solution pressure, the result of the existence of a potential difference will be galvanic action, and hence corrosion. This galvanic action would be between the intercrystalline material on the one hand and the crystals of ferrite on the other. Either of these may be the positive member of the couple, and lose weight. In a perfectly annealed specimen, in which there is but little mechanical strain, it is probable that the action will be confined to that between the ferrite and the cement. If there is any potential difference, however, between the crystal grains due to any cause, then this will add to the effect, and the total corrosion will be the sum of the two actions.

Taking the simplest case, namely, the one in which the ferrite is roughly at the same potential throughout, and the intergranular cement at another, then there should be an action developed at the junction of the two substances. The action may not be confined to this face of contact, but will proceed at a maximum rate on that plane. The result should be that the lines of junction of the crystals show this more intense action, and the evidence should take the form of a relatively deep pit sunk round the crystals. This evidence is to hand. This theory would account more or less completely for the corrosion of a pure metal.

Passing on to the question of solid solutions, several very interesting points arise at once. Assuming that the action in the case of steel containing carbide and solid solution is similar to that in those consisting of carbide and ferrite, that is, galvanic with the carbide as cathode, it should be evident that the controlling factor in this instance will be the solution pressure of the solid solution, and this will vary with the composition of the solid solution.

It will be granted that in all the alloys designed to resist corrosion, it will be necessary for the solution pressure (as reflected in the electromotive force) of the solid solution to undergo some considerable change from that of iron, in order that the difference of potential between the solid solution and the carbides shall be sufficiently small to minimise corrosive action. From the electromotive force curve it should be evident that there is no sudden change of solution pressure in the alloys forming the solid solution, and that in consequence it will be necessary for the solid solution to become relatively concentrated in the alloying element before the required change of solution pressure can be accomplished. The corollary to this is surely that there is only likely to be any diminution of corrosion if the new element finds its way into the solid solution early in the series, and also becomes present in reasonable proportions. For any element that goes into solid solution in the steel, a small percentage is not likely to be of the slightest value in resisting corrosion.

After elaborating his theory in respect to the presence of special elements, such as molybdenum, chromium, vanadium, tungsten, nickel, etc., and their presence in the solid solution, the author draws the following conclusions:—

(1) That the corrosion of a steel takes place purely by the action of the ferrite or the solid solution.

(2) That the action upon pure ferrite may be due entirely to the potential difference set up in consequence of the different solution pressures of the grains of the metal and the inter-granular cement, it being probable that this latter is possessed of a greater electromotive force.

(3) That the percentage of the third element added to iron and carbon in steels must be sufficiently great to produce a fairly high percentage in the solid solution, if there is to be any beneficial effect from the use of this element.

(4) That the electromotive force of the solid solution with respect to the corrosive liquid is the deciding factor in the corrosion of a steel.

(5) That the pearlite in a steel does not corrode as a whole, but as a mixture of ferrite and cementite, the disappearance of the latter being due to mechanical, and not to chemical action.

(6) That carbides are not decomposed by ordinary corrosive agents, and that they act merely as cathodes to the anode of the ferrite or solid solution.

Queries.

Sand Renovating.

I should be glad if any readers would give their opinion, based upon experience, of the merits or demerits of the various sand-renovating processes. —"ENQUIRER."

Removal of Cores from Steel Castings.

We occasionally have trouble with steel castings, inasmuch as the cores become tightly fixed in the castings and the sand-blast plant is unable to remove them in some cases. We should be very interested to know of some solution of acid or acids which would be likely to soften these cores and allow them to be removed.—"M. C. L."

ANSWER.

Contraction Cavities in Spur-Wheel Blanks.

With reference to the above in the May issue, it is quite evident that the main cause of the trouble is due to the segregation of the sulphur content, which, in the writer's opinion, is too high at 0.6 per cent. for castings of this class. The last element to solidify being sulphur, it follows that if quick cooling occurs before the complete solidification of a metal, the sulphur will be forced to that part of the casting where it exerts a pressure, preventing the closer crystallisation of the metals at the point effected, thus leaving a cavity. The same thing applies if the ratio of cooling is normal. The remedy is to lower the sulphur content to 0.03 per cent.; cast in dry sand at not too high a temperature, with a silicon content in the iron of 1.1 to 1.2 per cent., phosphorus 0.8 per cent., manganese 0.4 per cent., and carbon approximately about 2.5 to 3 per cent., though the latter may vary, due to absorption from the coke in the cupola if the material is imperfectly coked. Good hard metallic coke is preferable to cokes of softer quality.—D. McP.

Tool-Steel Research.

At a recent meeting of the Manchester Association of Engineers Mr. Dempster Smith, presented an interim report of the Tool Research Committee of the Association, appointed in 1914 to undertake tests in the heat treatment of tool steel to ascertain whether uniformity in results could be obtained in successive trials made under identical conditions. The operations of the Committee included tests made to ascertain whether a tool that has failed in use is less serviceable after being simply re-ground, and if so, whether heat treatment restores the tool to its original vitality. The report includes the opinion of several experts on the question of heat treatment and the possibility of obtaining uniform results, and deals with the effect due to carrying the heat treatment to different stages, normalising and tempering.

To assist in attaining the desired uniformity it was decided that, at the outset, only one grade of tool steel be used. The tools selected had a nose radius of ¼ in., a cutting angle of 70 deg. in a plane at 45 deg. to the length of the tool (this is equivalent to a front and side top rake of 14½ deg.), and a clearance angle of 6 deg. The tools were 1¼ in. square in section, whilst the cut and traverse were to be 3/16 in. and 1/16 in. respectively, and the cutting speed to be such as would give a 20 minutes' life to the tool when heat-treated according to the steel-maker's instructions. The heat treatment recommended by the maker was to raise the temperature slowly to about 800 deg. C. and then quickly to 1,275 deg. C. From observations made at the steel works it was found that, starting from a cold state, a 1¼-in. square tool took about seven minutes for the first stage and two minutes for the second stage of the treatment. The latter time was deemed sufficient to allow the heat to penetrate to the centre of the nose and to fuse the extreme cutting edge. As these tools were heated in the smith's fire, actual observations of the temperatures could not be made.

A two-stage high-speed gas-fired furnace was used for heat-treating the tools.

Four tools (Nos. 1, 2, 4 and 5) were forged and ground to approved shape, were heated for 7½ minutes in the low-temperature chamber at 820 deg. C., immediately transferred to the high-temperature chamber at 1,275 deg. C. where they remained for about 1¼ minutes (just long enough to produce a bright glowing strip about 1/16 in. broad along the cutting edge) and afterwards quenched in a molten metallic salt bath at 250 deg. C. The temperatures of the furnace chambers were observed by means of a Féry radiation pyrometer and that of the salt bath by means of an armoured mercury thermometer.

For the cutting tests the trials were made on a medium steel bar and without a lubricant. In all cases the test was continued until the tool failed, the nominal depth of cut being 3/16 in. deep by 1/16 in. traverse. The results showed a slight improvement on re-hardening tool No. 1, and an improvement in one case but not in another for tool No. 5. Tools Nos. 2 and 4 showed a decided deterioration on regrinding only after failure. This result was contrary to expectations, it being generally understood that the performance of a tool improves after the first failure.

An idea is held that high-speed steel is injured by repeated heating to a high temperature such as that required for hardening, and for this reason some engineers prefer to harden turning and similar tools in the smith's hearth, where the heat is concentrated at the nose of the tool. The results of these trials showed that two re-heatings do not appreciably impair the cutting quality of the steel.

It was then decided that tools Nos. 2 and 4 should be normalised, reground, hardened and tested again in order to see if the results first obtained by these tools could be equalled or perhaps improved upon. The normalising process here referred to consisted in heating the tool slowly (taking about ten minutes) to a dull cherry red (800 deg. C.), placing the tool in hot cinders and allowing it to cool. The normalising preceded the grinding and hardening processes. In both cases the speed, cut and other conditions were to be the same as prevailed in the first trials with these tools. In neither case did the results equal those obtained by these tools when new, and when the performances of tools which had been simply re-ground and re-hardened after failure were compared with tools which had undergone these processes, in addition to being normalised, it could not be found that any benefit had accrued from normalising.

It was concluded that in the case of formed cutters which have been unequally strained in machining or in annealing, the normalising process might tend to eliminate these strains, or perhaps reduce the risk of surface cracks, but it did not seem feasible that this process would have any pronounced effect on a lathe tool which has not been cranked, and which has been carefully forged and not hammered after the temperature has fallen below a cherry red, *i.e.*, about 900 deg. C.

The following conclusions were drawn from tests made up to this time :—

(*a*) That with freshly forged tools, hardened as stated and tested under identical conditions, it was possible to obtain results within 5 per cent. of the mean or within an extreme difference of 9 per cent.

(*b*) That the cutting capacity of a tool which has been tested as stated was not appreciably impaired by being re-hardened, as often as three times, but care must be taken to ensure that the whole of the previously injured part is removed in the grinding before re-hardening. In re-hardening a hardened tool the time taken for the cutting edge to reach the glowing stage appeared to be slightly greater than that for a soft tool.

(*c*) That with such tools, treated as stated, normalising did not appear to have any appreciable effect on the cutting capacity.

(*d*) That the subsequent performance of a tool which had been simply re-ground (after being hardened and failed, as stated) was not equal to the original.

Having regard to the fact that better results are often obtained with a tool which has been simply re-ground after failure than was obtained in the first instance, and that in no case did this occur in these trials, it was decided to obtain the opinion of several steel experts with respect to this phenomenon. One authority who does much testing for the different steel-makers, could find no fault with the method of heat-treating and testing, or suggest any alteration. He produced the results of a large number of tests of tools, all of which gave better results on being re-ground after failure. A second expert said he obtained the best results from tools heated in an ordinary smith's hearth, and the best final temperature was, in his opinion, between 1,300 deg. C. and 1,350 deg. C. A third authority could find no fault with the procedure or explain why the tool on being re-ground should give better results than in the first trial. He was of opinion that if

results were obtained within 10 per cent. of each other the experimenters would do exceedingly well, even with tools made from the same ingot. The manner in which the ingot was cast, heated, and drawn out, also the subsequent annealing process, precluded the possibility of consistent uniformity in the cutting capabilities of the tools. Subsequently, he communicated the following :—

(1) It is inadvisable to anneal an ordinary lathe tool after forging and rough grinding. So far as the quality of the tool is concerned, and apart from any possibility of an increased number of wasters, it is preferable to have an ordinary lathe tool made from an unannealed bar.

(2) The pre-heating temperature should be just short of the calescence change point, which in ordinary high-speed steel is rather below 850 deg. C. At such a temperature the time of heating is of no importance except in so far as the surface of the tool may become decarburised. If the pre-heating temperature is above the calescence change point, then in addition to decarburisation it is possible also for the crystalline structure to grow larger; but an excess temperature of 20 deg. or 30 deg. C. appears to make no observable difference.

(3) After the pre-heating operation the temperature of the tool should be brought quickly to the final hardening temperature, say 1,250 deg. C. The reason the heating must be done quickly is because at these high temperatures the crystalline structure grows coarser at a very quick rate, and in five minutes or less many kinds of tools would be entirely spoilt.

(4) Certain kinds of high-speed steel air-harden intensively, and tools of moderate dimensions, or toothed tools made from such steels, had better be air-hardened. But there are other steels which require oil-hardening in order to get anything like the best results. There are also steels which if oil-quenched are soft, but if air-cooled are much harder.

A fourth authority stated :—(1) That he got the best results by heating to near the fusing point and cooling in air, but this was only practicable on tools that could be easily ground up if the point was injured; this method of heating was safe and should result in uniformity as far as the hardening was concerned. (2) As regards re-grinding after failure this obviously depended on the cause of failure. If the tool, as often happened, was so hard that the edge "crumbled" instead of cutting, re-grinding usually gave better results, but if the tool was not hard enough re-grinding was of no use.

A fifth correspondent wrote that :—(1) The possibility of the nose of the tools getting slightly hotter than the other parts, thereby fusing the extreme edge, required that extra grinding should be done on such a tool. (2) It was a well-known fact that when a salt bath had been in use for some time, it became contaminated with particles of iron oxide, which floated about and might possibly attack any tools placed in the bath. (3) With regard to the advisability of re-hardening after the tool had once lost its cutting edge, it was his experience that this was not necessary, as in a great many instances it was found that a high-speed tool cut better and did far more work after the first re-grinding.

The sixth authority consulted was of the opinion that the tools had been handled too delicately, and that for good results in subsequent re-grindings the tools should be heated until the surface was blistered for a distance of about ⅛ in. from the nose. Of all the suggestions this seemed the most reasonable, and it was decided to take two new tools (Nos. 3 and 6), also two old tools (Nos. 2 and 4), treat as recommended, and test as before. After failure one old (No. 2) and one new tool (No. 6) were to be re-ground, whilst tools 3 and 4 were to be re-ground and re-hardened and all tested again. The tools were heated for 10 minutes (starting from cold) in the pre-heat chamber at 825 deg. C., and from 2½ to 2¾ minutes in the final-heat chamber at 1,275 deg. C. The latter time was required in order to produce the desired degree of blistering, and is about half a minute in excess of the time previously given to the tools at this stage. The tools so treated on being chipped at the cutting edge showed a somewhat coarse structure, the crystals being fully twice the size of those obtained in tools when treated as in the first instance.

The trials after treatment were more irregular, and on the whole inferior to the results obtained in the early trials with the old method of heat treatment. Considering that consistent uniformity was the object aimed at, the results in this series were disappointing.

With the object of obtaining uniform results, it was resolved to revert to the old limits of heat treating, and to cool the tools in an ordinary air blast, instead of the molten salts 250 deg. C., which had been used in all the tests up to this stage; but the results of this series showed no improvement on the first trials, and proved that uniformity was not to be obtained by normalising, and that however carefully the tools might be treated irregularities appeared to be unavoidable.

The remainder of the report records the Committee's experiences in watching expert hardeners at work, and the results of sundry cutting tests.

The Committee's conclusions are as follows :—

(1) Normalising shows no advantage for turning tools.

(2) A tool which has only been raised to the hardening temperature at the cutting edge will deterioriate on re-grinding, whilst one that has been overheated at the cutting edge will improve on re-grinding.

(3) The methods of hardening adopted by experts show great variation both as to furnace temperature and duration of treatment, but this report will give those interested some definite guidance.

SMALL FIRMS AFTER THE WAR.—In the course of a recent discussion before the Birmingham Section of the Institute of Metals on the future of the metallurgical industries, Professor T. Turner remarked that Birmingham was not a smelting centre; it was particularly a metal-using centre. There were in the city and district 20 metal workers to every one metal maker, and perhaps the proportion was much larger. The businesses had grown up from very small beginnings, the result being that at the present time there were in the city 350 brass-casting firms. The consequence of having so many had been that organisation was defective; there had been a great deal of competition, and the amount of scientific knowledge and guidance had been nil. He could not recall a single firm in the Birmingham district that dealt in brass casting alone that had a scientific adviser or even an analyst. In the future, he considered, big concerns would be the rule. The small firm could not make a big gun, nor undertake the manufacture of aeroplanes, nor the construction of a battleship. There would be a combination of the small firms, or they would be squeezed out. It must be through big firms that some of the work that was absolutely essential for the country would be done, and it was firms like those that could afford to pay adequate salaries to their officials, obtain scientific advice, and conduct researches. It was by the combination of organisation and scientific knowledge that success could be obtained. It seemed to him we must provide for the smaller firms, for, if we did not, obviously we could not have the big firms. The smaller firms would pay attention to specialities, but it would be by the big firms that the greater part of the work of the nation would be done.

Powdered Coal in the Open-Hearth Furnace.

In a Paper read by Mr. C. J. Gadd (chief engineer of the American Iron and Steel Manufacturing Company) before the Franklin Institute recently the author gave an account of experiments with different forms of burners applied to open-hearth furnaces and showed the cross-section of a furnace fired at one end and operated without gas producers (Fig. 1). With this furnace is connected an interesting arrangement of waste-heat apparatus, involving two steam boilers and an economiser, both arranged so that they can be by-passed when necessary for repairs, so as not to shut down the furnace plant. Other applications of powdered coal burning in iron metallurgy were described. The installation

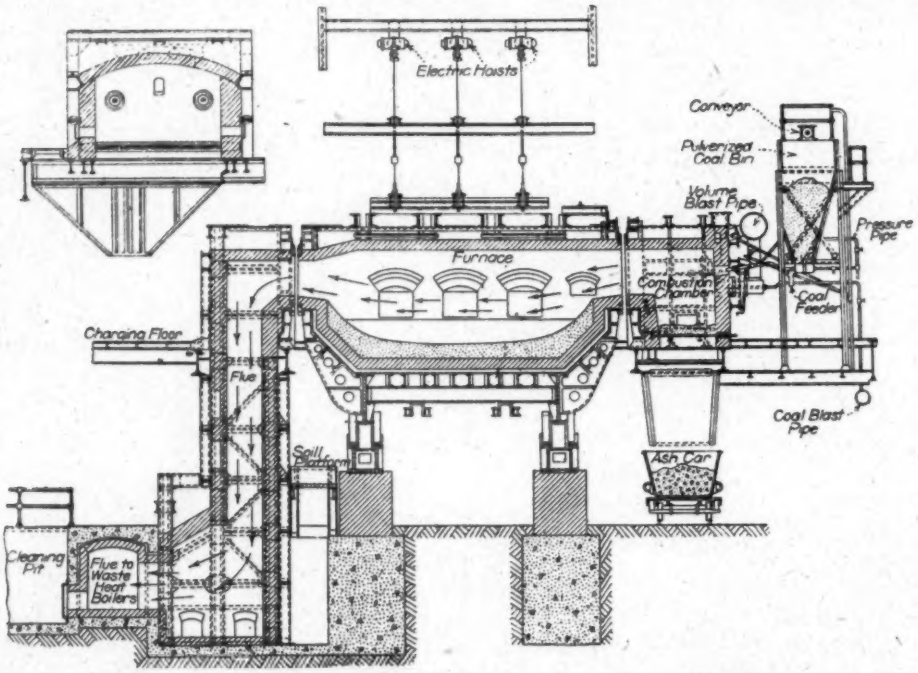


Fig. 1.—Open-hearth Furnace Heated by Powdered Coal.

represents a somewhat radical departure from the old-time theories of open-hearth furnace practice. The burners are arranged at only one end of the furnace and the path of the flame is always in one direction. The theory underlying this method of applying powdered coal in the open-hearth furnace is given by the author as follows:—(1) The fuel is burned above the bath, and all the heat contained in the coal is instantly developed in the furnace; (2) as the path of the flame is in one direction all parts of the furnace are maintained at the same temperature; (3) by reason of their high radiating capacity, the infinite number of minute incandescent particles in the powdered coal communicate the heat by radiation, and not by convection, thus eliminating the necessity of bringing the surrounding air to the temperature of the coal particles; (4) all the heat in the waste gases is conserved and used in the production of steam.

The extra fuel consumed, due to the use of cold air, is offset by:—(1) The elimination of all loss in the gas-producer process; (2) the elimination of all loss due to frequent reversals; (3) the elimination of all loss in waste heat taken up by the regenerative chambers; (4) the elimination of the expensive maintenance cost of producer plant and regenerative chambers; (5) the greatly reduced first cost of installation.

The author describes in detail the methods of distributing and storing powdered coal and the methods of preparation of the fuel. In the latter connection he calls attention to the fact that it is easier to dry coal to one half per cent. moisture or less than it is to maintain it in this state. He explains that the moisture driven off from the coal in the process of drying saturates the hot air contained in the dryer cylinder. In this highly saturated condition the air follows the dried coal through the dust-proof conveying system to the enclosed storage bin. As the coal and air cool, moisture is precipitated and the volume of the air diminished with the result that more warm saturated air is drawn from the dryer. The precipitation of moisture resulting from the cooling process of the coal and air may be almost entirely overcome by placing ventilating shafts on the storage bin and the high points of the conveying system connected with the outside air. However, in the process of drying through the medium of heat a small quantity of the expelled moisture will find its way back in the coal after cooling, and for this reason it is good practice to gauge the dryer so that the resultant product leaving the dryer will contain less than one half per cent. of moisture.

One of the most interesting parts of the Paper is that concerned with the burners. Fig. 2 shows a low-pressure powdered coal burner with its feed-

ing apparatus. An endless-flight conveyor chain is used for feeding a stream of powdered coal in a continuous shower across the air-blast ports. The excess fuel is automatically returned to the hopper by the endless-flight conveyor chain. The air-blast inlet nozzle connected with one side of the feeder case is reduced, the outlet side being flared, beyond which is a venturi tube used to induce higher velocity of the mixture leaving the feeder, thereby causing a slight vacuum or pull throughout the case. The cone extension on the hood of the burner enters the flared end of the coal-delivery pipe, breaking the solid shaft of coal and air and deflecting it around the inner periphery of the burner pipe. The mixture takes the form of a hollow ring, in the centre of which an auxiliary blast is discharged giving a thorough atomisation of the fuel particles as they enter the furnace.

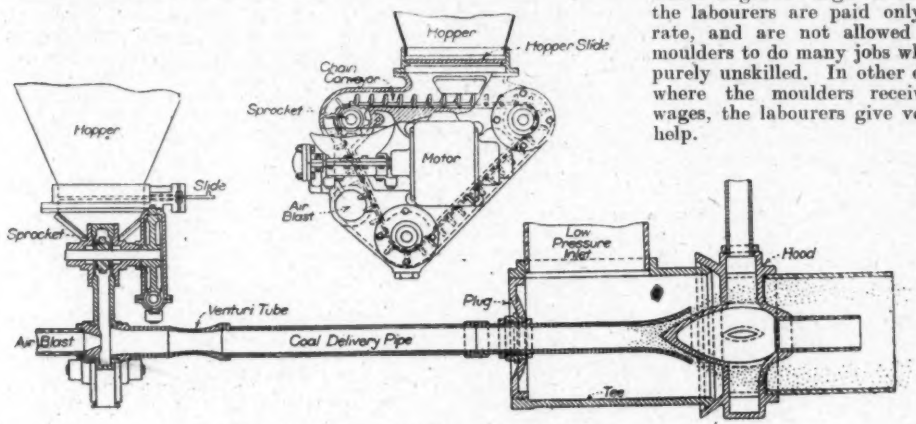


FIG. 2.—LOW-PRESSURE POWDERED COAL BURNER.

Feeders and burners of the high-pressure type produce a long flame through progressive combustion, and can only be used where the form of the furnace and the character of the work demand that an elongated cutting flame be developed in close proximity to the work done. This method of application is adapted to open-hearth furnace practice. In the type of feeders and burners described, the results obtained are equally good whether the powdered coal is injected into the furnace from the burners at a velocity of 1,500 ft. per minute, or of 25,000 ft. per minute.

The author puts the personal equation forward as the important factor in the operating part of the apparatus as developed thus far. In fact, he says that it is necessary to depend too greatly upon this uncertain element. In the drying process the operator may at any moment upset the complete equilibrium of a plant either by overheating the coal or by not drying it enough. In the furnace operation three or four separate adjustments are required depending on the burner used, each adjustment bearing a fixed relation to the others. These adjustments are the control of the coal feed, the control of the coal blast, the control of the volume blast and the control of the furnace draft where mechanically operated by low-pressure feeders and burners are employed.

[The illustrations are from "The Iron Age," and the abstract of the Paper is based upon a *résumé* appearing in the "Journal" of the American Society of Mechanical Engineers.]

Contrasts in Foundry Methods.

By R. A. Miles.

Many persons are astounded at the difference in the production of similar castings in different shops. It is not that men work harder in different districts, but that the method of production brings about this desirable result. In some districts, where wages are high for moulders, the labourers are paid only a low rate, and are not allowed by the moulders to do many jobs which are purely unskilled. In other districts where the moulders receive less wages, the labourers give very able help.

In foundries in high-wage areas, many hours are often wasted by moulders walking about the shop seeking tackle, not always because such tackle is not provided, but because there is no place allotted to it, and when there is, such tackle is more often than not never returned to that place. Many moulders will agree that they have been more tired trying to find gaggers than by any full day's ramming.

Jobbing shops and heavy engineering foundries are as a rule the biggest sinners in this respect. As a contrast, in any textile-machinery foundry it will be found that each moulder is supplied with tackle for his own use. He is taken as a new starter to the stores and given a spade, riddle, sieve, dry brush, wet brush or swab, loose tool box, hammer and mallet, water pot, a pot or box in which to keep parting sand and a blacking bag; and if he is put to make light castings, he is also supplied with rapping bars of various sizes, and he may, besides, have a pattern brush and a hammer with brass head, if he is to work with iron patterns.

Now as each other moulder is as well provided for, there is no need to borrow, and when a moulder is discharged or leaves, or is even absent from work, no matter what is the reason, some unskilled man is held responsible for the tackle, and consequently removes it to the stores, to be returned when the moulder recommences work, or a new man is started. Gaggers are placed each day at the end of each moulder's floor and a labourer is told off to collect them, and afterwards they are sorted and placed in boxes, each size having a separate pigeon hole; then when a moulder requires a fresh supply of gaggers, all he needs to do is to instruct a labourer to bring them from stock.

In heavy engineering shops, say, when the top box is lifted off, there is often one or two days' work for a moulder patching up and finishing this part of the mould. In the higher-rated areas one will see the moulder walk round the foundry looking for a sieve; when he finds it (and this is a difficult job in

some foundries) he strolls to the sand-mixing department and rubs some facing-sand through the sieve; then he throws the sieve down on the foundry floor and has another hunt, this time to find something to put his sand in. Perhaps he looks first for a wooden box, and unable to find one, he next goes outside the foundry to the scrap heap, where he may be fortunate enough to secure an old saucepan.

Contrast this with what happens in many lower-rated shops, where better wages are paid to labourers and more of them are employed. The labourer knows where to find the sieve and also the box to hold the sand, and as soon as the top-box is lifted from the mould the moulder is able to begin patching without any waiting.

Further, rules are in vogue in many foundries which often involve dismissal for any moulder found in another department. Yet some more progressive firms know the advantage they may gain by allowing the moulders to have access to the machine shops to follow their work, and by alloting a stated length of time each week for this purpose. The moulder then often saves his employer both time and money. He learns the best place to fix his runners or risers, and where to place chaplets, etc. If he is at all conscientious he endeavours to produce castings of such a character as will please every eye that sees them.

Again, it is quite the practice for moulders in highly-paid districts to pick up a riddle to fetch facing-sand, and if the job is of any size, they have to go quite a number of times to the sand-mixing department to get sufficient for their purpose.

How different in other districts, where an unskilled man would be told off for this job and this labourer, usually supposed to be less intelligent, would take a wheelbarrow and would dump down all the necessary facing-sand in a few minutes.

These differences in methods are not always the fault of the employers directly, but must eventually be brought home to them, because of their lack of knowledge of the actual conditions prevailing in their own foundries. Foremen are appointed who may be good moulders, but who have no initiative or no organising ability whatever, and the old conditions continue to prevail. Occasionally a foreman comes along from another district to manage one of the non-methodical foundries, and he is anxious to introduce a better system, but many excellent men have been compelled to relinquish their task before many weeks have elapsed, owing to the apathy of the owners, who probably bring forth a cost-sheet showing wages and number of labourers employed when a similar work's weight of castings was produced.

There are foundries known to the writer in which it is a sin for a labourer to dip gaggers in the clay-wash even. There are others where labourers must not use a rammer to help to ram a mould, yet the same men may be seen feeding a riser or ramming up a hole out of which a casting has been taken.

In a number of shops, moulders carry their metal in shanks from the furnace to their moulds. In some shops, however, they absolutely refuse to carry at the single end; but why should they be paid to do work of this description when labourers could be just as efficient?

Moulders as a class should be educated to the fact that they are employed to do the skilled part of making moulds, and that labourers are to do any unskilled part of the work. Labourers should be encouraged to make themselves efficient by increased wages according to ability and efficiency, and in this way many foundries could in a short space of time considerably increase their output at a reduced cost per ton.

War Committees and Commissions.

In view of the numerous War Trade Committees, Departments, and Commissions that have been appointed since the war started to deal with every possible contingency that might arise, few transactions can be carried out nowadays without reference to one or more of the committees. We reprint below a list of some of the departments and committees appointed which are of the most interest to our readers :—

Foreign Trade Department of the Foreign Office, The Controller, Foreign Trade Department, Lancaster House, The Mall, S.W.

War Trade Intelligence Department, Broadway House, Tothill Street, Westminster, S.W.

War Trade Department, secretary, Sir N. J. Highmore, K.C.B., 4, Central Buildings, Storey's Gate, Westminster, S.W.

Department of Import Restrictions, secretary, Mr. H. J. Phillips, 22, Carlisle Place, S.W.

War Trade Advisory Committee, secretary, Mr. L. C. Liddell, M.V.O., Winchester House, St. James' Square, S.W.

Foreign Trade Debts Committee, secretary, Mr. H. Mead Taylor, 119, Victoria Street, S.W.

Trading with the Enemy Committee, secretary, Mr. W. P. Bowyer, 38 and 39, Parliament Street, S.W.

Enemy Exports Committee, The Secretary, Enemy Exports Committee, Foreign Office, S.W.

Board of Trade Committee on Shipbuilding, secretary, Mr. T. G. Austin, Board of Trade, S.W.

Commission Internationale de Ravitaillement. (International Commission for the purchase of Supplies for the Allied Governments), secretary, Mr. R. F. H. Duke, Board of Trade (Exhibitions Branch), India House, Kingsway, W.C.

War Risks Insurance Advisory Committees, secretary Mr. J. W. Verdier, 33-36, King William Street, E.C.

Iron, Steel and Engineering Industries Committee. secretary, Mr Percy Ashley, Board of Trade, S.W.

Trade Relations after the War, secretary, Mr. Hartley Withers, 12, Tokenhouse Yard, E.C.

Committee on the Supply of Chemical Products, secretary, Mr. F. Gossling, Gwydyr House, Board of Trade, Whitehall, S.W.

Committee on Production in Engineering and Shipbuilding Establishments, secretary, Mr. H. J. Wilson, Offices of the Chief Industrial Commissioner, 5, Old Palace Yard, S.W.

Railway Executive Committee, secretary, Major G. S. Szlumper, 35, Parliament Street, S.W.

Excess Profits Duty Committee, joint registrars, Mr. D. du B. Davidson and Mr. J. K. F. Cleare, 133, Strand, W.C.

Board of Referees on Profits of Controlled Establishments, secretary, Mr. W. F. Wakeford, 27, Abingdon Street, S.W.

Committee on Work of National Importance, secretary, Mr. H. Gibbon Pritchard, 26, Abingdon Street, Westminster, S.W.

Reserved Occupations Committee, secretary, Mr. D. Todd. Gwydyr House. Whitehall. S.W.

With reference to the issue of certificates for the export of steel goods by the Liverpool Chamber of Commerce a letter has been received from the Board of Trade stating that "in connection with the issue of certificates in respect of steel exports it has been suggested that form B should be signed by manufacturers and not by consignors, as at present. The Ministry of Munitions of War concur in the Board's opinion that this alteration is desirable, and I am accordingly to request that in future applications to your chamber the signature of the manufacturer of the goods should now be required in the place of that of the consignor." At the request of the Board of Trade the Liverpool Chamber of Commerce has appointed a special committee to issue certificates for the export of steel and steel goods for which no licence is required.

British Foundrymen's Association.

Newcastle Branch.

At a meeting of the Newcastle and district Branch of the British Foundrymen's Association on May 17, Mr. W. Mathews presiding, a general discussion was held on the following subjects:—(*a*) Cast-iron borings; how to dispose of them. (*b*) Iron castings; why is it that most castings come out largely in excess of weight, in general practice? (*c*) Brass borings; how to dispose of them. Is there any appreciable loss in re-melting? If so, to what extent? Does ingot show any influence of contained borings? (*d*) Brass castings; what the cause of porous castings and suggested remedy?

The Chairman said the question of cast-iron borings and brass borings might be discussed together. The difficulty in using borings was the loss due to oxidation. In the case of brass borings, this loss might be largely prevented if the following plan were adopted:—Brass borings should never be put into a dry crucible. Ingots of virgin metals should first be melted sufficiently to make a bath of molten metal of, say, one-third the crucible capacity. Borings might then be added from time to time, care being taken that they were submerged beneath the surface, thus preventing to a large extent the chances of oxidation. Cast-iron borings presented a more difficult problem. Charging loosely into a cupola was bad practice. To take an analogy from brass borings, the proper plan would be to introduce them into the ladle. Other methods adopted were the squeezing together of the cast-iron borings into briquette form in a hydraulic press. Such briquettes could then be charged into the cupola. Cast-iron borings had also been packed tightly into deal boxes of about 1 in. thick timber, and then thrown into the cupola. The argument in this case was, apparently, that the wood box carried the borings down to the melting zone before it perished, and thus it prevented the oxidising influence of the blast in the upper layers of the charge. Whether the result intended was attained in practice it was difficult to say, and in any case it was a moot point whether the use of cast-iron borings in the foundry was worth the trouble.

The question of castings coming out largely in excess of proper weights, in general practice, might be countered by another query, "Is that result so general as suggested?" Assuming that patterns and core boxes were correctly made, nothing but malpractice on the part of the moulder, either in slack ramming or careless rubbing of cores and moulds, would cause large increase in casting weights. Another factor, over which the moulder had no control, and which operated in the direction of increased scantlings, was the well-known fact that ordinary grey foundry iron expanded in the mould just before solidification. Engineers who were extremely fastidious about their thicknesses should see that their patterns and core boxes were made to a thickness less than drawing dimensions, the amount to be determined by experiment.

The porosity of brass castings under water test might sometimes be due to making such castings in green sand, and if the sand was too damp the casting might be pitted by tiny steam jets during the pouring of the mould. Another cause of porosity in gun-metal casting was discussed in an exhaustive fashion in a Paper, "Practical Heat Treatment of Admiralty Gun Metal," read by S. G. and H. Primrose before the Institute of Metals in 1913. He recommended the members to carefully read it.

Mr. S. Dickinson said that with regard to green-sand moulding the chairman's experience was that the castings swelled. His experience had been all the other way; that they contracted.

The Chairman said that what he wanted to convey was that they had to make certain allowances for contraction. It had been clearly proved that ordinary grey cast iron in cooling actually expanded in the mould. After solidification contraction occurred. Just when the pressure came on, if there was a weak point, the metal found its way out, but after the weak point was passed then there was contraction. The period of expansion of the metal previous to solidification was the searching time for any mould.

Councillor Smith contended that there must be a weakness in the mould to cause extra thickness. For example, the moulder might not like the hard work incidental to hard ramming, and he found soft places where he should have uniform shape.

Mr. Carmichael said that if perfect castings were wanted then a perfect pattern was required.

How to Make Use of Technical Literature.

By S. Layson.

In order to keep in touch with the daily increasing scientific knowledge which is being brought to bear on the problems of industrial organisation, many of us purchase several of the leading technical periodicals, only to find that in a short time these same periodicals are occupying valuable space and are, to a large extent, unread. It is a great mistake to retain the whole of a periodical when perhaps only one or two pages contain anything of real interest to the individual. Also to attempt to read thoroughly even these portions, without retaining the pages for future reference, constitutes such a tax that after a while, and especially at a busy period, they remain unopened. Two methods of filing for reference have been found very satisfactory. The first is specially suitable for a private office, and the second for the use of an entire works staff.

In the first system the requirements are:—

(1) A quantity of loose-leaf binders, the number depending on the variety of subjects with which it is proposed to deal, and of such a size as to take the pages of the largest periodical perused. Each binder should be labelled for its particular subject and numbered.

(2) A quantity of plain loose leaves to suit the binders.

(3) An index book arranged alphabetically down the edge.

As a periodical is received any page or pages containing an article of interest should be torn out in entirety, and with the heading uppermost punched at the left-hand edge; then, with a loose leaf below, placed in the binder set apart for that particular subject. The loose leaf should be numbered in the top right-hand corner, working upwards from the back of the binder. The title of the article, also binder and page numbers, are then entered in the index book and cross references made if necessary. Thus each abstract is ready for immediate or future use. Where articles overlap on the same pages (even if they deal with different subjects) this method of indexing obviates the destroying of either of them.

In the case of this system for the use of the foundry manager the binders would cover, say :—(1) Cast iron, (2) malleable cast iron, (3) brass, bronzes, &c., (4) sand, (5) coke, (6) moulding machines, (7) foundry appliances, (8) furnaces, (9) cupola practice, (10) general subjects. A specimen page of the index book would be as follows :—

Sample Page of Index Book.

	Binder.	Page.
Coke—analyses of various brands ...	5a	7
Coke—physical testing of	5b	19
Cupolas—calculations on, etc., etc. ...	9a	4 and 18

For the second system the requirements are :—

(1) A cabinet with card index to drawers.

(2) Requisition forms.

(3) Small numbering labels (coloured).

This system is on the same principle as the first, but, being for general use, covers a greater variety of subjects and is a little more elaborate. It may be divided into three sections :—

(1) Collection of articles.—A selected number of periodicals are passed round to the various departments, the heads of which, after perusal, pencil-mark any article of interest or service to the firm. After thus completing the round of the departments each copy is returned to the main office, where, as before, the entire pages marked are cut out.

(2) Indexing the articles.—Each article is numbered on the bottom right-hand corner (preferably on a small coloured label and placed in the cabinet drawer assigned to that particular subject. The cabinet is supplied with a card-index system (with a duplicate set in each department if necessary).

(3) Issuing of articles.—On an article being requisitioned it is replaced temporarily by a recognised requisition form to indicate the department from which it can be obtained if required.

The Use of Magnesium in Industry and War.

In the course of a Paper on this subject read before the recent joint meeting of the New York sections of the American Electrochemical Society, the American Chemical Society and the Society of Chemical Industry, Mr. W. H. Grosvenor pointed out that while before the war nearly all the magnesium used in the United Kingdom and the United States came from Germany, both France and England were now producing in considerable quantities. The use of the metal for scavenging purposes, he continued, depended on the price of the metal compared with price of the material to be scavenged. For use with copper, brass, bronze, etc., magnesium could be used at far higher prices than for steel. But there could only be a big consumption of the material when it directly replaced aluminium as the predominant metal in the alloy, and arrived at a correspondingly low price. It made beautiful castings, machined easily and well, was about a third lighter than aluminium and could be made about twice to four times as strong. The coefficient of expansion reported was practically the same as aluminium. When properly pure (over 99.5 per cent.) it was apparently quite as resistant to corrosion as aluminium, equal if not superior in electrical conductivity (about half that of copper) and superior in heat conductivity to aluminium (also about half that of copper). At least one process appeared to be adapted to the direct production of metal averaging 99.6 per cent. purity in tons per day instead of pounds. Laboratory tests gave a raw material cost of about 2d. per pound of magnesium and indicated a fuel cost which approached 1½d. as a theoretical limit, though the practical figure would probably be several times as high. The final selection of various possible engineering means and methods remained to be worked out, but it scarcely seemed possible that either labour or repairs would exceed 1d. per pound. Thus if commercial yields maintained the experimental level and three times the theoretical power was commercially required, there were prospects of a net factory operation cost (without interest, depreciation, insurance, patent, administration of selling) of 8½d. per pound. If only 75 per cent. yield was obtained this net factory cost would be about 11d. or a total cost with all overhead expenses of 1s. 5½d. and a selling price of 1s. 8d. to 2s. 1d., according to tonnage. Few realised the extent to which magnesium was valuable in military work. One of the great foreign explosive experts stated that he would be glad to pay 6s. 3d. per pound for 500 tons. A single contract for shrapnel now being executed in the United States would require about 50 tons. Illuminating bombs consumed large quantities, and the trailers attached to shells served at night to show the effectiveness of the fire. For these purposes magnesium produced a result that could not be approached by antimony or aluminium. Then should be considered what it meant to aeroplane, dirigible, and motor construction, to high-speed engines of every type, to reduce the weight one-third and double the strength by the use of a material that had a density of 1.75 and could be hot rolled to a tensile strength of 35,000 lbs. per square inch or cold rolled very much higher.

USING PATTERNS AFTER STORAGE. — Even when castings are wanted without alteration from a pattern which it is certain has never been altered, it is seldom that the latter can be taken from the stores and sent into the foundry without requiring anything done to it in the pattern-shop. A pattern in regular use can be relied on, but one which has been out of use for a long time cannot. Wood is liable to shrink and warp, especially in a new pattern which has had time for this to occur, and has not received attention since being made. Shrinkage may affect important dimensions, but more frequently it causes overlapping joints which tear up sand in being drawn from the mould. The pattern must be examined for this and tested for truth on surfaces liable to warp, besides being measured and examined for breakage or possible missing details. A warped surface may be planed true if sufficient material can be removed without reducing too much the thickness of metal or over-all measurements. Sometimes battens are screwed on to pull the surface true, and are stopped off in the mould. In other cases a concave surface can be straightened by wetting the central part and causing it to swell, and so regain its original form. A part originally circular may become elliptical through shrinkage, and this has to be rectified, often by inserting a piece. Shrinkage in some places can be made good by putting pieces on. Sometimes the shrinkage may be in a place where it does not matter, or it may be so small in amount that it can be ignored. Damaged corners or other parts may have to be made good by letting pieces in. Fillets are often broken or missing and require replacement. Varnish wears off when a pattern has been moulded from a good many times, and more varnish must be put on, preceded by thorough glass-papering and scraping where necessary to remove roughness. Work of this kind has to be done on old patterns before they go into the foundry even when the castings required are similar to the previous ones.

Brass Melting by Gas Furnaces.

Discussing this subject recently in "The Gas World," Mr. Geo. Twist (District Superintendent, Doncaster Corporation Gasworks) remarked that the gas-heated crucible furnace has to some extent already attracted the attention of manufacturers, and there is every likelihood of its use becoming much more general in view of recent developments, comprising improvements in construction, increased duty per cubic foot of gas consumed, and longer life of crucibles. But it has been difficult in most cases to convince manufacturers that town's gas for melting on a large scale was financially a commercial possibility—except, perhaps, in some districts where coke commanded a fairly high price while gas could be obtained at exceptionally favourable rates. Small users were, perhaps, prepared to pay something extra for the undoubted conveniences of gaseous fuel, and one such expressed the opinion that the use of town's gas was a paying proposition if the consumption did not exceed 5 cub. ft. per lb. of metal (copper) melted. In this case 1s. 8d. per thousand cub. ft. was being paid for gas.

Tests in a brass foundry under working conditions, made under the supervision of the furnace makers' representative about three years ago, gave results as follows, 112 lbs. of gun-metal scrap being melted at each heat:—

	Time taken. Minutes.	Gas consumption Cubic Feet.
First heat (starting from cold) ...	85	660
Second ,, ...	55	380
Third ,, ...	52	345

These figures show an average of 4 cub. ft. per lb. of metal melted, and although this average might have been slightly reduced on a full day's work it is probably a fair approximation of the results obtainable under working conditions from the furnaces then available. There are furnaces now installed in foundries where the average gas consumption on a day's run is as low as 2.2 cub. ft. per lb. of brass melted, and over a week's working the average is only 2.4 cub. ft.

In addition to this reduction in fuel cost, a further improvement claimed for the modern furnace is in the lengthened life of the crucible. The average life in a coke furnace is about 35 heats, while with previous types of gas furnaces from 35 to 45 heats were obtained, but experience has demonstrated that with the latest furnace this may be anything from 50 to 80 heats, and an average life of 60 heats can, therefore, be expected. A case is known of a 60-lb. crucible yielding as many as 106 heats. Crucibles at present cost about 1¼d. per lb. capacity, and the cost of 150-lb. and 120-lb. crucibles may be taken as approximately 15s. 6d. and 12s. 6d., respectively.

Assuming, therefore, 3 cub. ft. per lb. of brass melted as a figure which can with reasonable care be maintained in actual practice, and taking into consideration the increased life of the crucible as above, an interesting comparison of costs may be made between gas and coke as fuels for melting purposes, the price of gas being taken as 1s. 8d. per thousand cub. ft. and good clean gas coke at 18s. 6d. per ton delivered at the foundry. The fuel consumption quoted above for coke furnaces was arrived at by careful checking of the weights of gas coke used and brass melted in a battery of furnaces during a normal day's working. Varying results will doubtless be obtained in different foundries, but it is probable that 50.4 lbs. coke per cwt. metal melted is below the average, and that in most cases a larger quantity of coke will be used.

Taking this figure as the basis for comparison, however, there is no great difference between the two methods of melting so far as the above costs are concerned, but the gas furnace becomes incontestably the cheaper when the many economies effected by its use are taken into consideration. For example, with the gas-fired furnace "skimmings" are reduced to an almost negligible quantity, and further, owing to its special construction, any spilled metal (through pot breakage or other causes) can be removed in a perfectly clean condition from the bottom of the furnace. With coke-fired furnaces the skimmings are a serious source of loss, and spilled metal is hopelessly mixed with the coke and ashes underneath the furnace.

Comparison of Gas-Fired and Coke-Fired Furnaces.

Gas-fired Furnaces (150-lb. Size).
(Average life of crucible, 60 heats of, say, 130 lbs. each.)

	Cost per Cwt. Brass Melted. Pence.
Fuel costs:	
At 3 cubic feet gas per lb. of brass melted (3×112×0·02d.)	6·72
Crucible costs:	
With average life as above and price 15s. 6d. each, (15s. 6d.÷70 cwts.)	2·65
Interest, etc.:	
Capital cost of furnace, say £50. Interest and depreciation at 15½ per cent. (7½ years)= £7, 17s. 6d. Add for repairs, say £3 per annum: total, £10, 17s. 6d. Assume each furnace to melt 10½ cwts. per day, or (10½×5½×50) 2,887 cwts. per year, £10, 17s. 6d.÷ 2,887	0·90
Air-blast:	
With melting capacity as above, interest and depreciation on blower, and power to drive same .	0·70
Total cost per cwt. melted . . .	10·97

Coke-fired Furnaces (120 lb. Size).
(Average life of crucible, 35 heats of, say, 100 lbs. each.)

	Cost per Cwt. Brass Melted Pence.
Fuel costs:	
50·4 lbs. gas coke at 18s. 6d. per ton delivered .	5·00
Crucible costs:	
With average life as above, and price 12s. 6d. each (12s. 6d.÷31 cwts.)	4·84
Interest, etc.:	
Capital cost of furnace, say, £10. Interest and depreciation at 15½ per cent. (7½ years)= £1, 11s. 6d. Add for repairs, say, £1, 10s. per annum. Total £3, 1s. 6d. Assume each furnace to melt 5½ cwts. per day, or (5½×5½×50)= 1,500 cwts. per year, £3, 1s. 6d.÷1,500 . .	0·49
Total cost per cwt. melted . . .	10·33

The case for gas furnaces is further strengthened by the saving effected in labour, as their use dispenses with the daily lighting up of furnaces, firing, clinkering and coke wheeling. This item, of course, varies according to the conditions obtaining in various foundries, but it is probable that in most cases the total saving effected under this head in melting and metal recovering costs will not be less than 2d. to 3d. per cwt. melted. In the costs for coke-fired furnaces given above, nothing is included for firewood, although this amounts to an appreciable item in a year's working.

The speed of the new type gas furnace is another important point in its favour. While the first melt with a 150-lb. crucible takes approximately 75 minutes, subsequent heats require only 35 or 40 minutes compared with the 75 to 90 minutes taken to do the same work in a coke-fired furnace. These two points, labour saving and speeding up of work, should appeal to manufacturers with particular force at the present time.

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Non-Ferrous Notes.

Scabbing of Gunmetal Castings.—Scabbing of gunmetal castings in green-sand moulds results either from the sand being too wet or the mould being rammed too hard and not allowing sufficient vent. The commoner cause of the two is lack of vent, but in either case the defect is directly caused by the metal being disturbed from the face of the mould after being chilled and not uniting properly again with the body of metal.

Bell Casting.—The following mixture has been recommended for bells for vehicles :—Copper 80, tin 20. The copper should be melted under a thick cover of charcoal, broken fine, and when thoroughly liquid half a pound of yellow prussiate of potash should be added, this being dropped on top of the charcoal and allowed to remain undisturbed for 10 minutes, when it should be stirred into the metal. The tin should then be added and a final stirring renders the metal ready for pouring.

Melting Scrap Nickel.—In melting nickel of any sort, of course, a high heat is necessary, and the work is very difficult and often impossible in an ordinary brass-foundry furnace. A blast may be regarded as essential. When melting scrap nickel a useful flux consists of three parts of lime to one of fluor-spar, well mixed. Two or three pounds of the flux should be used with 100 lbs. of metal, part being put into the crucible with the nickel and the remainder after melting.

Hardening Tantalum.—A process of hardening tantalum, invented by W. Von Bolton, consisted of alloying the metallic tantalum with from 1 to 10 per cent. of silicon, from 2 to 3 per cent. being recommended as the best proportions. The ductility of the tantalum was claimed to be not impaired, while the metal could be drawn into wire like the pure metal, and at the same time the hardness was increased. The alloy was intended for making incandescent electric-light filaments.

White Metal for Plumbers' Work. — The following alloy, said to be suitable for castings such as faucets, cocks, valves, etc., was the subject of an American patent a few years ago :—Copper, 60 parts; zinc, 23; nickel, 12; lead, 5; aluminium, 1½; white arsenic, 1½. The copper is melted in a crucible and 3½ parts of borax added. The white arsenic is then stirred in and the nickel introduced. When melted, the zinc, lead, and aluminium are added, and the mixture is ready for casting.

Melting Points of Metals.—In our last issue were given the melting points of various metals. Herewith are the melting points of some other metals as determined by H. Von Wartenberg (Germany). The temperatures were measured by a Wanner pyrometer :—

	Deg. C.	Deg. F.
Vanadium	1,710	3,110
Rhodium	1,970	3,578
Iridium	2,360	4,280
Molybdenum .. over	2,550	4,622
Tungsten	2,900	5,252

The metals were as pure as possible. It is stated that the vanadium used was of 97 per cent. purity.

Iron in Scrap Aluminium.—Methods of dealing with fine scrap aluminium such as turnings and chips have considerably improved of late years, but no matter what method of recovering the metal is employed it is important to keep the scrap free from iron and steel, which is very liable to contaminate turnings. The similarity in colour of iron and aluminium renders separation difficult except by a magnetting apparatus. When iron does occur in the metal during melting it alloys up to considerable proportions, and the effect is to make the aluminium short in fracture and coarse-grained, while it also hardens it. The melted metal in such cases also tends to be thick and pasty.

A Platinum Substitute.—Owing to the scarcity of platinum at the moment, any substitutes for that metal are of interest. An alloy for use in contact and spark devices intended to replace platinum has been patented by P. R. Heyl (U.S.A.), and consists of silver and palladium in varying proportions, according to the conditions under which it is to be used. An alloy of silver containing 2 per cent. palladium has been found to give good results under many conditions. When the contacts or spark points are exposed to sulphur compounds, 5 per cent. or more of palladium should be used. Additions of palladium to silver raise the melting point and lower the thermal conductivity.

Tantalum - Carbon Alloy for Surgical Instruments.—The use of tantalum as the metal for making dental and surgical instruments has been claimed to give better results than the use of steel. The tantalum is very hard and non-corrosive and has a high melting point. It is alloyed with a small quantity of carbon to harden it, and then may be worked like steel and can be made to take a cutting edge. It is also stated not to be brittle, and that instruments may be made thinner than those of steel and still have the desired properties. The tantalum is not attacked by any fluids met with in the use of the instruments, and it may be readily cleaned and rendered antiseptic.

Silicon in Copper Castings.—When using silicon (in the form of silicon-copper) as a deoxidiser in casting copper castings the copper should be carefully melted under cover of charcoal, heated slightly beyond pouring temperature. The silicon-copper broken into small fragments should be introduced piece by piece until agitation of the metal surface ceases. The metal should then be poured quickly. Large gates should be used and ample pressure given by the rising head. For casting purposes the amount of silicon is a matter of judgment, regard being had to the behaviour of the metal. After pouring the sinking in the head of the gate, caused by its feeding action, should be greater than in the case of brass or bronze alloys.

Toughening Beeswax for Modelling.—In order to toughen beeswax for modelling the addition of 1 oz. of diachylum to 1 lb. of wax has been recommended. The beeswax and diachylum are melted together and coloured red with a mixture of equal parts of crocus and rouge. About 1 oz. of the mixture is added to 5 lbs., of the melted beeswax and diachylum. When this has been done and the mass thoroughly mixed, it is poured out on a piece of marble or metal and allowed to cool. It is then broken up and remelted to improve it. The crocus is added to allow free cutting and serves to keep the tools in good condition; the rouge is used to colour the mass. Diachylum is made by heating olive-oil with red lead until a soft substance (plastic but not sticky) is formed.

Tellurium-Silicon Alloy.—Among the very limited applications for tellurium in metallurgical work may be mentioned its use with silicon to form an alloy for lightning-arrester resistances, heating units, etc. This was patented by J. T. H. Dempster (General Electric Company, U.S.A.), the tellurium content ranging from 1 to 15 per cent. The method of making is to melt the silicon and tellurium together in a crucible, or covered with calcium carbonate which is decomposed by the silicon and forms silica. The calcium oxide then unites with the silica forming calcium silicate, which acts as a slag. This is the method preferred. The best mixture was considered to be that with 5 per cent. of tellurium, the resistance of the silicon being thereby increased from 3 to 5 times without making it brittle.

Zirconia Crucibles.—Zirconia, or the oxide of zirconium, has been mentioned by one German writer as an excellent material for crucibles for melting metals. The crucibles were made in the following manner :—Zirconium hydroxide was obtained by precipitation and pressing through a filter-press. A small amount of starch was added to hold the crucible in shape while drying. The mass was moulded in the form of a crucible in a press, then air dried, heated gently for some time and finally to a temperature of from 2,000-2,300 deg. C. in an electric furnace. The crucible thus obtained was fairly strong, resisted chemical reagents

well and was extremely indifferent to sudden changes of temperature. The hot crucible could be plunged into water without cracking it. The expense of the material, however, would appear to prohibit its use except for laboratory purposes.

Alloys Used in Zeppelin Construction.—The alloys entering into the construction of a Zeppelin brought down in France are given as below by the *Revue des Produits Chemiques*, with their analyses :—

	Angle Brackets. Per cent.	Channel Sections. Per cent.	Braces. Per cent.
Aluminium ...	90.27	88.68	89.07
Zinc ...	7.80	9.10	0.13
Iron ...	0.45	0.43	0.58
Silicon ...	0.37	0.49	0.36
Copper ...	0.73	0.70	0.06
Tin ...	0.11	0.15	—
Manganese ...	0.27	0.45	—
Nickel ...	Trace	Trace	Trace

The braces are evidently commercial aluminium, while the other parts are alloys of aluminium, zinc, copper and manganese. The absence of magnesium is noticeable. The impression has been that this metal was extensively used, at least as an alloy.

Spongy and Rising Gates.—Most founders have at some time or other met the trouble of gates swelling and rising after the metal in the mould has presumably set, and various courses of action have been suggested to save the castings. But when these mushroom or swelling heads occur no remedy save scrapping and remelting the metal is satisfactory. The cause can almost invariably be referred direct to the furnaceman, for it lies in the absorption of gases during melting. If the metal is melted too slowly, and particularly if it is allowed to "soak" in the furnace after melting, gases are absorbed which are given out on cooling and setting of the metal. The gate being usually the hottest and last to set affords the easiest exit for the gases, but in such cases the casting itself is almost certain to be a mass of extremely fine holes, even though the surface may appear good. A casting with a rising gate of this character cannot be expected to stand test under hydraulic pressure, for example, and might as well be scrapped straight away.

Magnalium.—This name is employed to cover a variety of alloys of aluminium and magnesium, though most of the alloys sold under the title have only 1 or 2 per cent. of magnesium, with other metals, such as copper, nickel, and tin present in small quantities. The composition is governed largely by whether the alloy is to be cast or drawn. The specific gravity is generally about the same as that of pure aluminium, except when the magnesium content is relatively high, and that of other additions low, when it is less than the specific gravity of pure aluminium. Magnalium is superior to aluminium in strength and ease for working, and is a very suitable alloy for parts of scientific instruments and similar apparatus. For some special work up to 6 or 7 per cent. of magnesium has been used, but it is found that such alloys are difficult to cast in sand except in very light forms. The difficulty appears to result from the molten metal decomposing the water present in the mould, and combining with the oxygen thereof, at the same time releasing the hydrogen, which may or may not be absorbed, depending upon the temperature of the metal. The presence of other elements, such as calcium, together with the foregoing, produces porous castings with the surface decomposed, or castings that are sound and tough, but coated a white powder with black specks extending throughout the interior of the metal. The alloys containing a low percentage of magnesium are easiest to cast.

Permanent Graphite Moulds.—Permanent moulds made of graphite, for making non-ferrous castings, are the subject of a patent granted to Charles Vickers (U.S.A.). The moulds are made of graphitised carbon used preferably in the form known as artificial graphite. This is exceedingly refractory, and is resistant to high temperatures and, therefore, the mould can be used repeatedly. The substance is a rapid heat conductor, and consequently has a rapid chilling effect on the metal, preventing liquation. Graphitised carbon is capable of having its heat-conducting property modified and adjusted to meet the requirements of different metals or even different parts of the same casting. For example, Mr. Vickers has constructed these permanent moulds from graphite, either artificial or natural, with a binder such as tar or pitch, the whole being baked in a furnace much as in ordinary carbon manufacture. He adjusted the heat conductivity to that required by adding a certain amount of amorphous carbon, determined to be sufficient to reduce the heat conductivity of the mould. The moulds may also be made wholly from the amorphous carbon and then graphitised in an electric furnace. Here again their heat conductivity can be adjusted as required. By correspondingly adjusting the temperature of the furnace, the extent of the graphitisation of the amorphous carbon is regulated and thereby the heat conductivity of the mould controlled. The heat conducting properties of the permanent mould can be adjusted locally by varying its thickness at different points or zones, corresponding to the thicker and thinner parts of the castings, and by this means is insured more rapid heat withdrawal from the thicker parts and less rapid from the thinner parts of the mould. If a permanent mould is not required, a temporary mould can be made from a form of graphite obtained by the decomposition of silicon carbide or other similar carbides, since this form possesses plastic, coherent properties when subjected to pressure. Also, the temporary mould may be made from a mixture of graphitised carbon and moulder's sand, regulating the proportions so as to obtain the degree of heat conductivity desired. Tests with an alloy containing aluminium, 92 per cent., and copper, 8 per cent., cast in four different moulds made respectively of sand, amorphous carbon, iron and graphitised carbon showed that these four substances are superior to each other in heat conductivity as moulds in the order named, that of sand being the least and that of graphitised carbon the greatest, the tensile tests and elongation obtained being greatest in the latter. In view of the rapid chilling in the graphitised carbon mould, it is necessary to employ risers or feeders of ample size made of a lower heat-conducting substance or mixture than the mould itself. The riser is made of moulder's sand, and by its use the casting is continuously fed until solidification takes place. With the use of the graphitised carbon permanent mould the relative proportions of riser to casting are claimed to be materially reduced.

A NEW BRAZING PROCESS.—At a recent meeting of the Manchester Geological and Mining Society a demonstration of a new material, "Bondite" (Cooke's process) for use in brazing cast-iron, steel, etc., was given by Mr. Gervase W. Cooke. He pointed out that well over 90 per cent. (by weight) of all machines, tools, engines, etc., consisted of cast-iron, and great waste was involved by the scrapping of expensive castings. In the ordinary way a cast-iron surface would not take brazing spelter, and except for parts of small dimensions and in the most expert hands no flux was known by which the operation could be accomplished. "Bondite" claimed to overcome the difficulty. By its use a cast-iron or steel surface would take the brazing spelter just as tin would take solder. One advantage with regard to brazing repairs was that after the operation the joint and the metal surrounding were as soft and tough as the virgin cast-iron, and could be machined as readily; the joint was, in fact, stronger. When tested to destruction under the most adverse conditions the joint on the line of braze could not be rebroken. The equipment necessary was simple and easily transported, the working cost extremely low, and no special training was required. The working temperature was much lower than the acetylene and other welding processes. "Bondite" could be applied where high-temperature processes were not possible, which was a matter of importance in motor repair work.

The Electric Furnace in Steel Manufacture.*

By Dr. John A. Mathews.

With the advent of electric furnaces we have a rival which claims to make steel equal to the best crucible steel. It is interesting to note that the inventors recognised the superior character of the crucible product so frankly. Equally frankly I can say, after 10 years' experience, that I think they were right; nevertheless, we are building four new crucible furnaces at the present moment.

When I say that the electric furnace can produce steel equal to crucible steel, I mean that conditions in the furnace are such that the metal in the ladle, ready to pour, is in approximately the same condition as well-melted crucible steel. The quality of the finished product, however, depends upon the use of equally good methods of handling the ingot in cogging, rolling, annealing and inspecting that are customary in handling fine tool steel.

The point is that each process has its particular field, and while some crucible tonnage may be diverted to electric steel, yet it is more likely that electric steel will find its market in the most exacting requirements of steel for structural and tensile purposes, such as have come about almost simultaneously with the processes themselves, namely, for automobile and aeroplane parts. Crucible steels for these purposes are scarcely commercial because of the difficulties attendant upon making very low or medium carbon alloy steels by that method, and the tonnage demand is far beyond what could be met by crucible steels.

Our own experience shows that the electric furnace was opportunely invented to meet a new demand rather than to replace an old process. Our demand for crucible products has not decreased, but the reverse; and while each and every grade that we manufacture can be and has been successfully produced in one or both of our electrical processes, the fact remains that they are better adapted to the production of relatively low-carbon alloy steels.

The pioneer work that we have done in introducing electric steels into the States has had the effect of creating new standards of value for alloy products and, indirectly, has brought about a general improvement in the quality of open-hearth steels upon the part of mills specialising in these products.

I fear there may be some misapprehension as to just what an electric furnace will do. It is not an automatic machine guaranteed to produce steel of crucible quality by merely manipulating a switch. It requires at least as much skill as any other existing process, and the number of men possessing this skill is limited. I believe we shall pass through a period of reaction and dissatisfaction with electric products while many of the new furnaces are in the experimental stage.

Changes in Electrical Equipment.—The most marked change in the electrical equipment of furnaces consists in the larger quantity of power deemed necessary for a given size of furnace. In our original furnace we have 550 k.v.a. for a 4-ton furnace. To-day the United States Steel Corporation recommends 900 k.v.a. for a furnace of this size. Some of the older 6-ton furnaces have from 900 to 1,000 k.v.a. available; 1,200 k.v.a. is now standard, and one furnace is to have 1,500 k.v.a. The Snyder furnace has 800 k.v.a. available for a 3-ton furnace, and the Héroult furnaces, as installed in the States, are now equipped with 750 k.v.a. for this capacity. It has been found that increased power during the melting-down stage is very desirable and brings about a saving in total kilowatts expended. After the melting is complete excessive power is detrimental to the heat itself and very destructive of roofs and linings.

It is possible to make electric steel chemically purer than by any other process. Phosphorus with us rarely exceeds 0.010 per cent., and sulphur in carbon heats will average still lower, while in alloy heats the sulphur rarely exceeds 0.015 per cent. This is true of both the Héroult and Snyder product; in fact, I have seen eight consecutive heats showing sulphur and phosphorus below 0.010 per cent. In the case of sulphur, we view this not so much as of itself important, but as an indication of the success in attaining a reducing and deoxidising condition during the operation.

In the case of both low- and high-carbon heats of a great variety of compositions, we have split many ingots in two and have never seen a cavity or blow-hole, either subcutaneous or deep-seated, even so large as a pin-head. This is no positive guarantee that unsound ingots may not result even with electric steel, and the approved methods of pipe prevention must be employed, together with every possible care in melting and pouring. Even with the use of all these precautions, the same results cannot be obtained in open-hearth and Bessemer steel, owing to the oxidising conditions of operation.

An advantage of the electric product scarcely anticipated by Siemens is the ability to control the composition within narrower limits than are possible in open-hearth practice. This is especially noticeable in the use of the more easily oxidisable metals, such as silicon, manganese, chromium, and vanadium. This is an advantage in several ways:—(1) Less excess alloy needs to be added to the heat to ensure the proper amount in the finished steel; (2) the quantity of solid metallic oxides in the steel, or to be eliminated from the steel, is thereby reduced; and (3) the more nearly composition can be controlled the more certain will be the results of heat-treatment.

Both the maker and the user of the steel are the gainers by reason of the above characteristics, as well as by the fact that all alloy additions may be made in the furnace itself rather than in the ladle, thereby removing danger from lack of homogeneity. Not only in automobiles and aeroplanes, but in many other ways, electric steel will give a good account of itself here, as it has done abroad, for military and naval purposes.

The furnaces already installed in the States, or now being built, represent the utilisation of between 125,000 and 135,000 electrical horse-power and will be capable of a tonnage output of between 1,000,000 and 1,100,000 tons of ingots or castings per annum. The Héroult system represents at least 70 per cent. of this electrical energy and tonnage output.

Steel Corporation's New Furnaces.—The recent announcement of electric furnace development in the plants of the United States Steel Corporation is deserving of especial mention because of the magnitude of the installations. At the Duquesne

* From a Paper read before the American Iron and Steel Institute. Dr. Mathews is president of the Halcomb Steel Company, of Syracuse, N.Y., U.S.A.

Works of the Carnegie Steel Company, a 20-ton Héroult furnace is now under construction, which will operate on liquid open-hearth metal from any of the 32 open-hearth furnaces at that plant. It is estimated this furnace will produce about 200 tons of ingots per day of 24 hours.

At the South Chicago Works of the Illinois Steel Company, where a 15-ton furnace has been in operation for several years, three additional electric furnaces, two of 20 tons' and one of 15 tons' capacity, are now under construction. These furnaces will receive liquid open-hearth metal from the duplex plant, consisting of three 200-ton tilting open-hearth furnaces and two 25-ton Bessemer converters, also under construction at these works. This installation, when completed, it is estimated will produce 800 tons of electric steel ingots per day and will represent by far the largest electric furnace installation in the world.

Discussion.

In the discussion that followed the reading of the Paper, Mr. Carl H. Booth (Snyder Electric Furnace Company, Chicago) said that Snyder furnaces to-day, melting and refining cold material, on a basic bottom, were making from 6 to 12 heats in 24 hrs., depending on the grade of steel made and the methods used for handling the metal. It was not at all uncommon to melt down an entire charge of cold scrap in 1½ hrs., and they had many records where the actual melting had been done in 1 hr. 10 min. This quick melting ability in an electric furnace made unnecessary and expensive the use of other furnaces, such as the open-hearth or Bessemer, either to do the preliminary melting or part of the refining. He believed that the developments of the future would be in the direction of doing all work in the electric furnace, except in cases where hot blast-furnace or mixer metal was available as raw material, for use direct in the electric furnace. His company were designing an electric furnace of approximately 12 tons holding capacity, which would have a daily output of 100 tons of steel, melting and refining cold scrap on a basic bottom. The steel made would have an analysis equal to the best low-carbon open-hearth steel, and the operating cost promised to be low enough to compare favourably with an open-hearth furnace having a daily output of 100 tons.

Mr. Leslie E. Howard (Simonds Manufacturing Company) said the experience of his company had been entirely with small furnaces of the conducting hearth type. Their furnace was of 1-ton capacity; it had operated very successfully, and had also been used in producing high-grade carbon steels as well as alloy steels. He thoroughly believed, as stated by Dr. Mathews, that steel equal to crucible steel could and was being produced every day by electric furnaces, but his experience, limited though it was, had convinced him that to do this crucible practice must be followed very closely in the choosing of melting stock, care being taken in melting, especially during the "killing" period and, of course, extreme care in pouring and subsequent handling of the ingots. A certain amount of new iron should be added to even high-grade scrap if quality steel was to be produced. He had had occasion to talk with several Sheffield melters and metallurgists who said that to get "body" and "life" in their steel they were obliged to use liberal quantities of new iron, this holding good whether the steel was made by the crucible or other process. In American crucible practice it of course was well known that liberal additions of puddled iron, either Swedish or American, gave crucible steel increased physical properties for the same analyses, and having in mind that the puddling process was about as crude an operation as any in their iron and steel metallurgy, he could not see why the same proportionate amounts of high-grade pig-iron combined with good scrap and all melted and refined in the electric furnace would not make steel equal to crucible quality. His company had installed and were now running a 6-ton 3-phase Héroult furnace.

Labour Advisory Committee.

The Labour Advisory Committee, announced by the Right Hon. Walter Long, M.P., during the progress of the Military Service Bill, is now sitting. It consists of Mr. G. J. Wardle, M.P. (chairman), Mr. Charles Duncan, M.P., and Mr. Stephen Walsh, M.P. Its main functions are:—

1. In connection with the Recruiting Department of the War Office—
   (a) To act as a medium for sifting and communicating any labour complaints against the Recruiting Department.
   (b) To deal with allegations as to industrial compulsion.
   (c) To facilitate labour measures for getting men for the Army, including men wanted as artisans for Army work.
2. In connection with the Reserved Occupations Committee, to consider—
   (a) Changes in list of certified occupations.
   (b) Other matters requiring special action as to particular trades.
3. Generally, to keep the Government informed, through the President of the Local Government Board, of any labour matters affecting military service which call for attention.

The committee is sitting daily at the Central London Recruiting Offices, Great Scotland Yard. All communications should be addressed to the Secretary, Room 2, Great Scotland Yard, Whitehall, S.W.

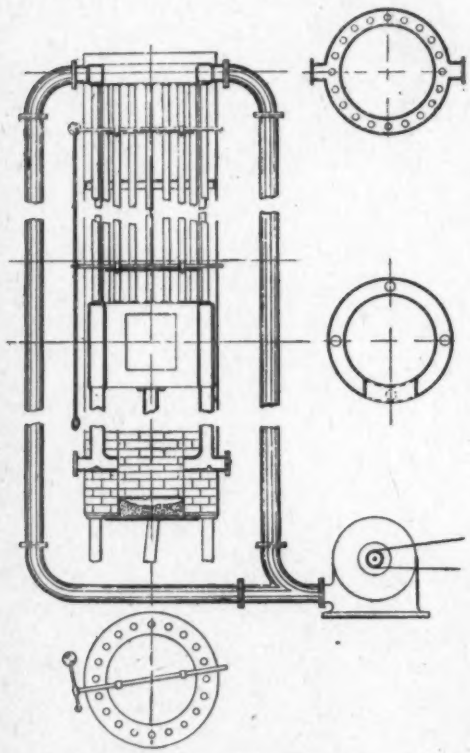
VACUUM FUSED IRON.—A paper on "Vacuum Fused Iron, with Special Reference to the Effect of Silicon" was presented by Prof. T. D. Yensen, University of Illinois, before a recent meeting of the American Institute of Mining Engineers. Dr. Yensen's conclusions are in part as follows:—"By means of the vacuum method of melting it is possible to obtain a decidedly purer product than has thus far been obtained in any other manner. Consequently by the use of this method more definite conclusions than have hitherto been possible can be drawn with regard to the effect of silicon upon iron. Silicon, like boron, has a double effect upon iron. Part of it combines with the iron and remains in solid solution throughout the cooling of the alloy, while a smaller part reduces the iron oxide present. The tensile strength of the vacuum product follows in general the same law as alloys made under ordinary conditions, but the ductility of the former is much greater, particularly below 2 per cent. and above 3 per cent., probably due to the absence of carbon. The maximum tensile strength of 105,000 pounds per square inch occurs with a silicon content of 4.5 per cent. The limit of forgeability lies between 7 and 8 per cent. silicon. A critical range occurs between 2.50 and 2.60 per cent., in which the alloys are exceedingly brittle—in some cases being not even forgeable. The chemical composition of the latter corresponds to a compound of the formula $Fe_{19}Si$. With regard to the magnetic properties, the vacuum alloys exhibit most remarkable characteristics. The best alloys are obtained with about 0.15 per cent. and 3.40 per cent. silicon after annealing at 1,100 degrees Cent. The maximum permeability for both of these alloys is above 50,000, and the hysteresis loss for maximum fluxes of 10,000 and 15,000 is about 300 and 1,000 ergs per cubic centimetre per cycle respectively. This hysteresis loss is one-eighth and one-third of the corresponding loss for commercial silicon steel. The most favourable annealing temperature is in every case, 1,100 degrees Cent. The specific electrical resistance increases about 13 microhms for the first per cent. silicon added. For each additional per cent. added the increase is about 11 microhms. Consequently th 3.40 per cent. alloy has a resistance nearly five time. that of the 0.15 per cent. alloy."

Cupola with Pre-Heated Blast.*

By J. A. Parsons.

In the ordinary cupola the consumption of coke to melt the iron is governed:—(*a*) By the quantity of the metal to be run, as the heat absorbed by the cupola is much the same in a long or a short cast, and the quantity in the bed is much the same. (*b*) By the cleanness of the iron from dirt, sand, etc. (*c*) By the hardness of the metal to be melted.

In steam practice economy in fuel has resulted in condensing and superheating in the hot gases in the flues. So far little attention in this direction has been applied in cupola work. In the type of cupola illustrated herewith the air blast, instead of coming into contact with the bed of the coke cold, is passed through a series of tubes in the top or chimney of the cupola, and reaches the coke bed at first only slightly warm, in a few



Cupola with Pre-heated Blast.

minutes at a temperature that melts lead, in a few more minutes at a heat which burns zinc, and after the blast has been on, say, twenty minutes at approximately over one-third of the total temperature required to be imparted to the iron. After over seven months there is no apparent deterioration to the pipes used in the heat catching, due to the travel of the air in the pipes.

A steam pre-heater has the chance of gathering heat from the gases resultant from a fairly complete combustion of the fuel, whereas in cupola practice this pre-heating device has the same as regards one-half of the fuel, but has, in addition, the opportunity of catching approximately two-thirds of the total heating power of the other half of the coke, which is generated round the tubes of the device in the completion of the combustion of the CO into CO_2. The modern authorities on the chemistry of cupola practice compute that one-half of the coke is burned (or combined with oxygen) to CO_2, in which combination each pound of coke generates 14,540 B.Th.U. Also that the other half of the coke is only burned to CO, in which each pound of coke evolves only 4,320 B.Th.U., and that this same CO is finally turned into CO_2 in the top of the cupola, and the difference of the heat of each pound of coke of this second half of the total coke, namely, 10,229 B.Th.U., is entirely lost in the ordinary practice, it being evolved after leaving any useful area. The combustion of this CO is easily recognisable by the pale sapphire blue flame noticeable in a cupola chamney.

With the device herewith illustrated, the evolution of CO is not claimed to be altered, but when the CO is burnt to CO_2 in the top of the cupola the heat there evolved is to a large extent absorbed into the blast through the tubes instead of being allowed to waste.

Some advantages claimed for this cupola are: (*a*) Economy of coke, from 30 to 39 per cent., according to duration of cast. (*b*) The quality of the metal is improved. (*c*) The tuyeres do not slag up, as the hot blast does not cause precipitation, so labour is saved. (*d*) The furnace can be held up temporarily as by diminishing the blast, yet the balance of the blast comes in so hot that the melting can be reduced in proportion and without cooling down the furnace unduly. This allows great flexibility of operation. (*e*) Cost is small and manufacture easy for any foundry. (*f*) The capacity of the furnace is much increased, as a 24 in. cupola can handle up to two tons per hour with a 6 oz. blast, whereas the text book size for similar work is 34 in. diameter with a 7 oz. or 8 oz. blast. This makes for economy in first cost and repairs.

* From the Journal of the South African Institution of Engineers.

Applications for Patents.

The names of communicators are printed in Italic type. A new number will be given when the Complete Specification is accepted.

Dawkins, W. A. Forming blocks of metal cuttings, etc., for melting. 7,144. May 19.
Kohn, M. M. Electric furnaces. 7,014. May 17.
Stassano, E. Stirring molten metal. 6,946. May 15.
Davenport, S., and Stobie, V. Electrodes of electric melting and heating furnaces. 7,244. May 22.
Hall, I. Furnaces for melting metals, etc. 7,251. May 22.
Idris, W. H. W., and Ross, W. O. Alloys of aluminium. 7,507. May 26.
Wigley, F. S. Crucible furnaces. 7,434. May 25.
Davis, J. C. Casting processes and apparatus. 7,805. June 1.
Hall, I. Casting metal, etc. 7,830. June 2.
Sandberg, C. P. Apparatus for treatment of steel. 8,004. June 6.
Connolly, J. Metallurgical furnaces. 8,506. June 16.
Ionides, A. C. Gas-heated furnaces. 8,461. June 15.
Kitchen, H. J. Electric furnaces, etc. 8,533. June 16.
Rouse, T. Direct production of iron or steel. 8,443. June 15.
Fearnley, E. O. and the Metropolitan Works. Crucible or melting-pot. 8,597. June 19.
Hadfield, Sir R. A. Manufacture of manganese steel. 8,655. June 19.
Hadfield, Sir R. A. Manufacture of manganese steel. 8,805. June 22.
Hall, I. Means for melting and casting metal, etc. 8,611. June 19.
Keith, G. & J. Crucible furnaces. 8,795. June 22.
Lundberg, E. K. H. Smelting-furnaces. 8,871. June 22.
Monneron & Guye. Method of manufacturing an aluminium preparation. 8,878. June 23. (Switzerland, June 5.)
Skelley, J. M. Steel alloy for manufacture of tools. 8,631. June 19.

Trade Talk.

THE Ingersoll-Rand Company have been elected members of the Swedish Chamber of Commerce for the United Kingdom.

A FIRE occurred on May 26 at the premises of Messrs. E. Bibb & Sons, brassfounders, Windmill Street, Birmingham. The damage was serious.

J. DAMPNEY & COMPANY, LIMITED, of Cardiff, have established a branch at 30, Sandhill, Newcastle-on-Tyne, under the management of Mr. J. Dykes.

THE CENTRAL ZINC COMPANY, LIMITED, is being wound up voluntarily, with Mr. E. Davis (Messrs. Deloitte, Plender, Griffiths & Company) liquidator.

THE importation into the United Kingdom of manufactures of aluminium, baths, stoves and ranges, etc., has been prohibited, unless under licence granted by the Board of Trade.

MESSRS. H. W. LAKE & D. CURRIE, carrying on business as consulting engineers, at Norfolk House, Laurence Pountney Hill, London, E.C., under the style of Lake & Currie, have dissolved partnership.

THE firm of Reid & Company, electrical engineers and contractors, Motherwell, has been dissolved by the retirement of Mr. A. Reid, one of the partners. The business will be continued by Mr. H. Reid under the same style.

MESSRS. T. H. PICKLES, E. Pickles, A. Pickles, and R. H. Pickles, carrying on business as general iron-founders, at Empress Foundry, Mytholmroyd, near Halifax, under the style of T. H. Pickles & Sons, have dissolved partnership.

THE partnership heretofore subsisting between Messrs. G. W. Corbett and A. S. Corbett, carrying on business as engineers and iron and brass founders, at Park Street Works, Wellington, Salop, under the style of Samuel Corbett & Son, has been dissolved.

MESSRS. N. W. KIDNER, of the Islip Furnaces, Thrapston, and S. G. James, of Wolverhampton, carrying on business as S. G. James & Company, 58, Exchange Buildings, Birmingham, have dissolved partnership. The business will in future be carried on by Mr. N. W. Kidner.

THE STANDARD SHIPBUILDING & ENGINEERING COMPANY, of Chepstow, have announced their intention of establishing works on the banks of the Wye. The scheme, it is reported, includes among other works accommodation for the construction of vessels of over 460 ft. long and 60 ft. beam, and provides for the erection of a large number of dwelling-houses. The work will be put in hand almost immediately.

THE Monometer tilting furnace is now constructed for coke firing as well as oil and gas. The Monometer Manufacturing Company, Limited, have lately taken orders for their furnaces from, among other firms, Siemens Bros. & Company, Limited, London Bronze and Metal Foundry, Interlock Metal Hose Company, National Galvanisers, Limited, B.S.A. Company, Limited, Boulton & Paul, Limited, Thos. W. Ward, Limited, Blackwell's Metallurgical Works, Limited, Mellowes & Company, Limited, Crompton & Company, Limited, Williams, Harvey & Company, Limited, Nobel's Explosives Company, Limited, Lead Wool Company, Limited, Piston Rings, Limited, Thos. Firth & Sons, Limited, Jos. Lucas, Limited, Motor Stamping Company, Darlington Wire Mills, Limited, Metal Smelters Company, Limited, and Greenwood & Batley, Limited.

ROWNSON, DREW & CLYDESDALE, LIMITED, 225, Upper Thames Street, London, E.C., send us a copy of letter which has been sent to merchant interests in the London iron and steel industries. The letter states that the London Chamber of Commerce is now taking a considerable interest in business recommendations to the Government, as regards legislation after the war and arrangements for dealing with the present conditions. Unfortunately the metal trade section, dealing as it does with the largest industry in the world, is poorly attended, and any recommendations are made purely on the authority of possibly half-a-dozen attendants. London, not being a manufacturing but a merchant centre, this section should be thoroughly representative of the merchant interests of London. Up to the present the Government in all legislation seem to have ignored the merchant interest, whereas, especially so far as export is concerned, they are conversant with the requirements of the country. Unless this section is more supported, resolutions are likely to go forward diametrically opposed to the interests of the merchant.

DR. WILLIAM GARNETT, in an address on "Technical Instruction after the War" delivered on June 17 to the Association of Teachers in Technical Institutions, said it was not possible at present to mention in public what had been done for the Admiralty, the War Office, and the Ministry of Munitions in the laboratories of universities and technical colleges and by scientific societies and their members during the last two years. When the full record was made public it would command the attention of the industrial world, and there should no longer be need for the work of committees on the neglect of science. It was not in scientific discoveries of the first order that this country fell behind her foreign rivals, but in the lack of that patient course of investigation necessary to render the scientific discovery a commercial asset, as well as in the want of readiness on the part of manufacturers to utilise the scientific resources of the country to assist them in their difficulties. Dr. Garnett advocated the formation of associations composed of the manufacturers belonging to a trade or group of trades which would ascertain the subjects on which research should be undertaken and advise the trade with respect to this work.

LORD HALDANE and the other members of the Royal Commission on the Welsh University paid an informal visit on June 23 to Swansea. They drove to the the Technical College, and after an inspection of the building a conference was held Lord Haldane opened the proceedings by saying that the Commission was in Wales on a voyage of discovery, and they were groping about amid unlimited possibilities in a search for information with regard to the best means of dealing with University education in the Principality. Sir Alfred Mond placed before the Commission the importance of technical training being associated directly with industries. He pointed out the possibilities of a technical college at a place like Swansea, which was the centre of manufacture of every metal. Sir William Osler said he thought there were opportunities for Swansea's college becoming not merely the metallurgical centre of Wales, but with greater assistance and encouragement it would be possible to make it the metallurgical centre of the world. In the afternoon the Commission visited the Mond Nickel Works, the Mannesmann Tube Works, the Morfa and the Hafod Copper Works, the Swansea Vale Spelter Works, and the Cwmfelin Tinplate and Steel Works.

A BOARD OF TRADE licence has been granted to the Pearson and Knowles Coal & Iron Company, Limited, of Warrington, and to the Lilleshall Company, Limited, to manufacture German appliances for the automatic filling of blast furnaces. The announcement was made in the course of the hearing of an application by Newton, Chambers & Co., Limited, of the Thorncliffe Ironworks, near Sheffield, to make exactly the same mechanism. The patents are 27290 of 1904, 20598 of 1907, and 19294 of 1909. The companies have been granted licence to use these patents upon agreement to pay a royalty of £250 per installation erected. In the hearing of the application of Newton, Chambers & Company, Limited, counsel for the applicants explained that the patents were of 1904 in the name of the J. Pohlig Aktien Gesellschaft, of 1907 in the name of Aumunde, and of 1909 in the name of the J. Pohlig Company. The present applicants were ready to pay the same royalty (£250) on each mechanism manufactured. They were engaged almost entirely on munitions work at present, and the Ministry of Munitions had asked them to increase their output. This mechanism would enable them to do so, and would also liberate 30 or 40 men for military service. It would save a great deal of labour of a severe kind. Messrs. Newton, Chambers & Company already had the machinery, and were prepared to begin at once with the manufacture of these installations. They required

them for themselves primarily, but were prepared, once they had started, to supply others. The Controller said that he and the Deputy Controller would report to the Board of Trade recommending that the licence should be issued.

MUNIFICENT gifts towards a fund for the erection and maintenance of a technical college at Middlesbrough, making an available total of £60,000, were on June 5 announced at a joint meeting of representatives of the Cleveland Institution of Engineers and of the educational authorities of Middlesbrough, Stockton, and the North Riding. The money thus placed at their disposal will enable those concerned to proceed without delay with the scheme. It will be remembered that Dr. J. E. Stead, F.R.S., offered £500 as the nucleus of a fund for the erection and equipment of a metallurgical laboratory. This lead has now been followed up by a generous offer from Mr. Joseph Constantine, head of the Constantine-Pickering Steamship Company, Limited. At the meeting it was announced that Mr. Constantine is prepared to provide a sum up to £40,000 as the maximum for the erection of a suitable building for the technical college in Middlesbrough, on condition that the building is erected on the site in Borough Road, to be provided by the Middlesbrough Corporation, that the building, when completed, is designated "The Constantine Technical College," and vested in the Middlesbrough Corporation as the educational authority; that the equipment of the college is provided by public subscription, and the upkeep of the college provided for by Government grants, students' fees, and the balance from the local rates. Mr. Constantine also stipulated that the scheme of government shall provide for adequate representation of technical lay experts, and reserve the right to him and his successors to appoint two representatives on the governing body. Mr. Constantine's offer was supplemented by Sir Hugh Bell, who promised £10,000 on behalf of the firms with which he and Mr. A. J. Dorman are connected, and Colonel Hawdon promised £5,000 on behalf of Sir B. Samuelson & Company, Limited.

Legal.

Monometer Furnace Action.

Mr. Muir Mackenzie, one of the High Courts official referees, on June 27, had before him in London an action, part heard at Birmingham, in which the Monometer Manufacturing Company claimed from the Electric and Ordnance Accessories Company Limited, Ward End, Birmingham, for the balance of charges for supplying specially constructed and designed apparatus, consisting of furnaces for melting aluminium and other metals, together with the necessary plant for drawing off and carrying away the materials so melted. Defendants said plaintiffs had failed to supply furnaces according to contract, which were reasonably fit for melting aluminium for the production of their castings free from iron or other foreign matter, and free from porosity and flaws. Defendants also said the furnaces had failed to comply with the contract in other respects, that they had not been delivered to time, and that they had suffered damage in consequence of the breach of contract, in respect of which they counter-claimed for a sum approaching £11,000.

Defendants' case, which was opened at Birmingham, was remanded, when Mr. Willmott, defendants' works manager, was further cross-examined by Mr. Colem, K.C. He said the average heating power of the furnaces was not sufficient, and consequently they could not get their output. In making the contract he wanted to get furnaces without compressed air or other forced draught, and the plaintiffs represented their furnaces would do this.

The Official Referee, after some further evidence, reserved judgment.

Postponement of the Whitsun Holiday.

We are officially informed that the following letter has been addressed by the Ministry of Munitions to the Shipbuilding Employers' Federation and the Engineering Employers' Federation:

SIR,—I am directed by the Minister of Munitions to refer to the interview which members of your federation had with Dr. Addison on June 6 in regard to certain questions arising with respect to the postponement of the Whitsun holiday, and to make the observations set out below on each of the principal points raised. In doing so I am to point out that, in view of the unparalleled circumstances under which the present action is taken, this action cannot be taken as in any way a precedent for future occasions.

1. In cases where extra allowances of pay for work during the deferred holiday are made in accordance with the Prime Minister's statement, upon whom will the extra financial charge fall?

On this I am to reply as follows:

(*a*) As regards controlled establishments, any extra expenditure proved to have been incurred by them through payment of an enhanced rate of wages in accordance with the Prime Minister's statement will be allowed as an expense to be deducted in determining the profits under the Limitation of Profits Rules. This will cover private work in the establishment as well as munitions work.

(*b*) As regards uncontrolled establishments undertaking work for the Ministry of Munitions and the Admiralty, where it is proved that the extra expenditure incurred through payment of an enhanced rate of wages in accordance with the Prime Minister's statement has been such as to involve clear hardship, the Minister and the Admiralty will be prepared to consider the cases with a view to any necessary adjustments. This will apply also to any controlled establishment in whose case it is proved that there is no margin of excess profits against which the extra expenditure could be set.

2. In the case of a district where there has not been a universal custom or practice, but some shops have made these special allowances, and others not, what is to be done in the case of the latter?

As regards this question, I am to state that the view taken by the Minister is that the attitude to be adopted in each individual shop, in the absence of a definite agreement or custom for that shop, must be determined by what was the ruling practice in the district.

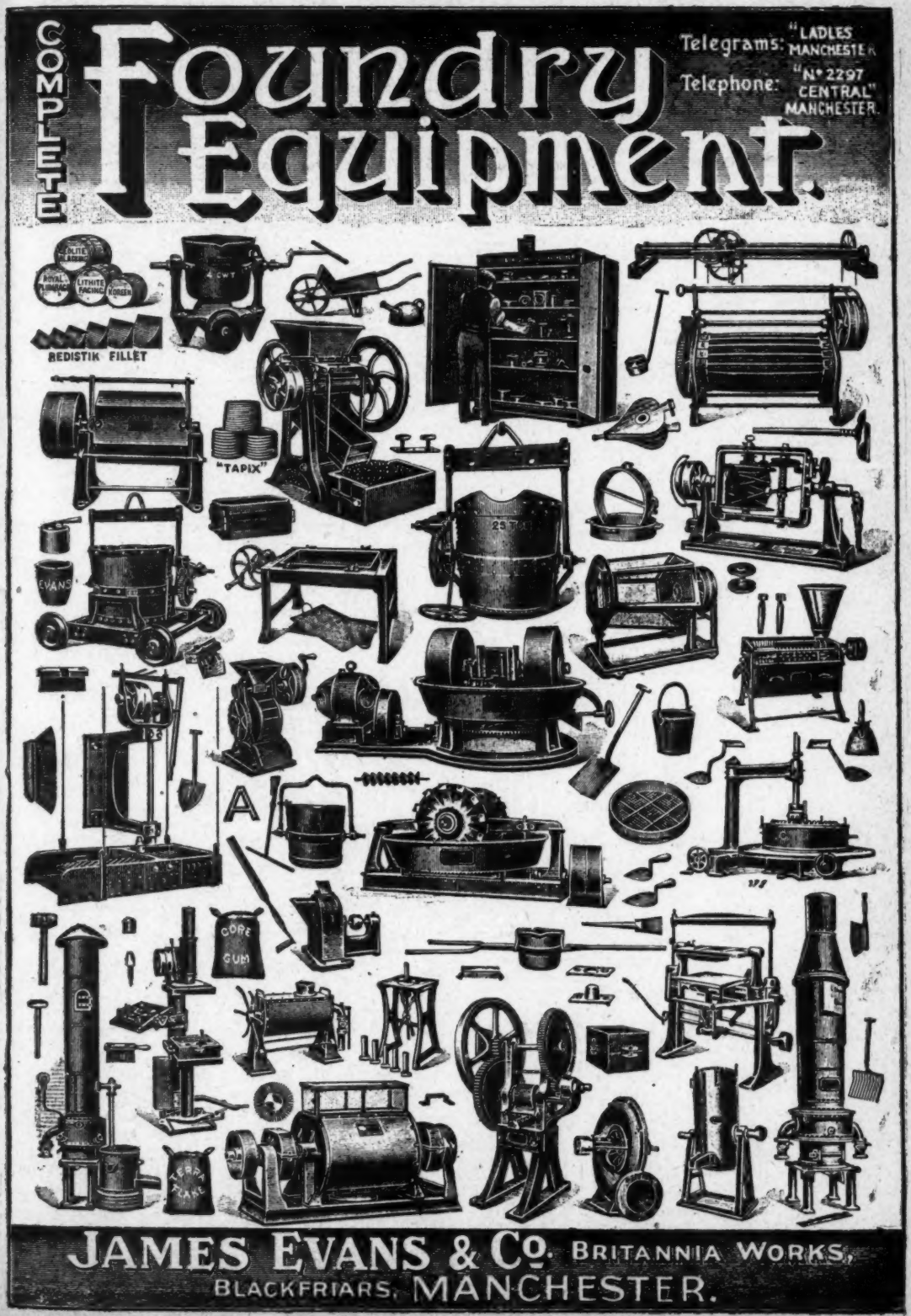
3. In certain shops there may be agreements affecting certain classes of workpeople and not others, or agreements providing different rates of additional pay for different classes of workpeople. What is to be done in these cases?

In reply I am to state the view of the Minister as follows:

(*a*) Where any class of workpeople in a shop receives additional pay under an agreement, it will in general be found necessary that other classes (including women employed in the same shop) should receive some additional payment.

(*b*) At the same time it appears quite admissible that for any good cause (in particular, definite agreements) there should be different additional rates for different classes of workpeople, even in the same shop.

4. It has been suggested that in some cases claims for extra pay unwarranted by any agreement or custom, or by the terms of this letter, may be put forward. Such claims should not be entertained. The postponement of the holiday is required in the national interest, and the Minister is confident that under these circumstances no demands will be pressed to the extent of declining to work.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Foundry Equipment.
Telegrams: "LADLES MANCHESTER"
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"TAPIX"
JAMES EVANS & Co. BRITANNIA WORKS,
BLACKFRIARS, MANCHESTER.

Deaths.

THE death is announced, after a short illness, of Mr. J. Dempster, of R. & J. Dempster, Limited, manufacturers of gas plant, Newton Heath, Manchester, at the age of 62 years.

MR. T. M. HALE, who for many years conducted an extensive brass foundry business at the Bute West Dock, Cardiff, died recently. Mr. Hale formerly had an extensive establishment at Bristol.

MR. D. JOHNSTONE, sole surviving partner of the firm of Johnstone & Clark, ironfounders, Queensberry Iron Works, Dumfries, died on June 16, aged 67 years. He was at business as usual a few days prior to his death.

THE death is reported of Mr. D. Napier, consulting engineer, Glasgow. Mr. Napier was the eldest son of the late Mr. J. D. Napier, engineer, Glasgow, and a grandson of Mr. D. Napier, the famous shipbuilder and engineer.

MR. JOHN M. RODGER, head of the firm of J. M. Rodger & Sons, ironfounders, Kyle Foundry, Ayr, died on May 20. He began business many years ago and built up a large connection, in the development of which he had been assisted for many years by two of his sons.

MR. WILLIAM PATON, engineer, Muirhouse, Shieldmuir, died recently, aged 74 years. He began business on his own account nearly 30 years ago, and succeeded in building up a large connection. The business is now carried on by his sons under the style of Andrew Paton & Company.

DR. ELMER L. CORTHELL, president of the American Society of Civil Engineers, has died at the age of 76 years. He designed many American bridges, and was also identified in river and harbour work. He planned and was chairman of the International Engineering Congress of the Columbian Exposition.

THE death has occurred at his residence, Clifton House, West Bridgford, Nottingham, of Mr. Lorenzo W. Crosta. Up to a year or so ago he was the managing-director of the Nottingham Railway and General Engineering Company, and among his inventions were the Arnes-Crosta pipe, and an ingenious method of electrically repairing faulty tramway lines.

MR. JOHN SPENCER, who was known as the oldest ironmaster in Scotland, died at his residence, Kirkwood House, near Coatbridge, on May 24, aged 82 years. He was the founder of the Phœnix Iron Works and Drumpellier Iron Works, Coatbridge. He took an active part in local public affairs, being one of the original members of the Coatbridge Town Council, and having served in turn as councillor, bailie, and treasurer.

MR. JOHN MURRAY, managing director of Glenfield & Kennedy, Limited, engineers, etc., Kilmarnock, the first limited liability company registered in Scotland, died recently, aged 89 years. Mr. Murray was a practical moulder, and became connected with Glenfield & Kennedy, Limited, on its formation. He had introduced machine moulding into Kilmarnock, and thus simply revolutionised the repeat trade in the lighter class of castings.

MR. FRANK BRAILSFORD, manager of the works of Messrs. Ley's Malleable Iron Castings Company, at Derby, died at his residence at Littleover on June 16 after a long illness. He was 56 years of age. Mr. Brailsford, who was a native of Nottingham, had been engaged at Messrs. Ley's for over 30 years. He succeeded to the position of works manager on the retirement of Mr. H. M. Gray, J.P., having formerly managed the chain belt department.

THERE died at Exeter on June 12 at the great age of 90 years Mr. Charles Emile Müller, who was for very many years closely identified with the iron trade of Middlesbrough. Mr. Müller, in the fifties, came from Germany to be foreign correspondent for Messrs. Bolckow, Vaughan & Company, Limited, and in 1863 he founded the firm of C. E. Müller & Company, iron and iron-ore merchants, a firm which has achieved a very high and deserved reputation throughout the trade both here and on the Continent. Mr. Müller, who became a naturalised British subject early in the sixties, married a Scottish lady, who predeceased him, and leaves one son, Mr. T. Neil Müller, who is associated with the firm at Middlesbrough, and two daughters. The deceased gentleman, who was much respected on Tee-side, retired from the business some years ago, and went to reside at Exeter.

WE regret to announce the death of Professor Silvanus Phillips Thompson, Principal of the Finsbury Technical College, which occurred last month after a short illness. The deceased was born at York in 1851. At an early age he took his B.A. degree at London University, but, with a distinct preference for chemistry and physics, he abandoned the position he held as science master at his old school in his native city and attended lectures at the Royal School of Mines, continuing his studies at the University of Heidelberg. In 1875 Professor Thompson obtained the degree of B.Sc. at the University of London, being bracketed first in honours, and three years later he graduated D.Sc. In the same year he was appointed to the chair of physics at Bristol University College, where he had for some time been lecturing, and there he worked till in 1885 he was elected Principal of the City and Guilds Technical College, Finsbury, a post he held with the chair of physics at the same institution till his death. He had a special affection for optics and made several contributions to the theory of light, but he was perhaps best known for his work in electricity. He was elected President of the Physical Society, of the Institution of Electrical Engineers, of the Röntgen Society, and of other learned bodies, an LL.D. of Birmingham, Fellow of the Royal Society, and member of many other societies.

Personal.

LORD RHONDDA has resigned his seat on the board of the Ebbw Vale Steel, Iron & Steel Company, Limited.

MR. R. A. BRUCE, of Verona, West Park, Yeovil, has joined the board of Petters, Limited, engineers, Yeovil.

THE late Lieutenant Edward Workman, a director of Workman, Clark & Company, Limited, left estate valued at £14,754 gross.

THE late Mr. John Henry Davidson, a director of the Glengarnock Iron & Steel Company, Limited, and Merry & Cuninghame, Limited, left £31,131.

LORD SYDENHAM has resigned his seat on the board of Sir W. G. Armstrong, Whitworth & Company, Limited, on his appointment as a member of the Air Board.

SEC.-LIEUT. J. C. BRUCE JONES, who has been severely wounded, is a director of Jones & Campbell, ironfounders, Larbert, and of Jones Buckie Ship & Shipyard, Limited.

THE late Mr. D. D. Spence, chairman of Peter Spence & Sons, Limited, chemical engineers, Manchester, has left estate of the value of £74,899 gross and £74,084 net.

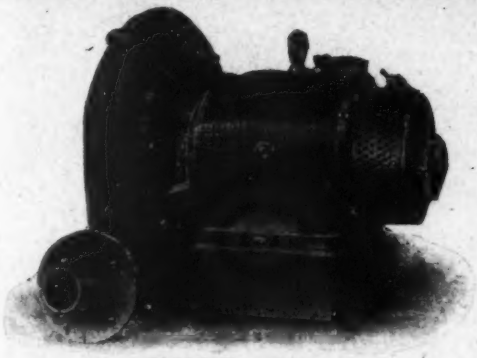
THE late Mr. J. W. Gardiner, senior partner in the firm of Messrs. Lingford, Gardiner & Company, engineers, has left estate valued at £6,191 10s. 8d., with net personalty £5,400 3s. 1d.

MR. F. DUDLEY DOCKER, C.B., chairman of the Metropolitan Carriage, Wagon & Finance Company, Limited, has joined the Committee of the Council for the Organisation of British Engineering Industry.

THE gross value of the estate of the late Mr. J. T. Hogg, of Barry, head of the firm of Messrs. J. T. Hogg & Company, engineers, iron and brass founders, etc., is £10,875, of which £10,626 is net personalty.

MR. C. P. PERIN, of New York, has arrived in this country on his way to India, where he will present to the directors of the Tata Iron & Steel Company, Limited, a report on the projected enlargement of the company's plant at Sakchi.

JUDGE GARY, chairman of the United States Steel Corporation, has been elected president of the Canadian company, known as the Canadian Steel Corporation, Limited, and Mr. Ward B. Perley has been elected vice-president and general manager in charge of construction.



10 H.P. Fan and Motor.

TRADE SIROCCO MARK

High Pressure Fans

Are made in a large number of sizes from 10 in. diameter upwards.

Bulletins 2000 F. and 2028 F.

Some Points worth noting.

Owing to few wearing parts, the Fans are not liable to break down. The mechanical efficiency is high and remains so. The pressure is steady and the volume even and free from pulsations.

Davidson & Co., Ltd.,

Sirocco Works,
BELFAST.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,

FIRE CLAY.

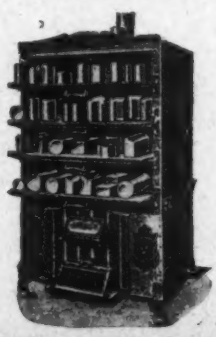
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."



THE "PORTWAY"

PORTABLE CORE OVENS

For Gas or Fuel.

TESTIMONIAL.

From The Braintree Castings Co.,
Chapel Hill Foundries, Braintree, Essex.

Gentlemen,

We are very pleased with the Core Oven we recently purchased from you. We find it dries the cores quickly without burning them. It is very handy and economical to use and is altogether superior to other ovens of this type we have in use.

Will you please quote us your best price for four more like it,

Yours faithfully,
For The Braintree Castings Co.,
(Signed) W. B. LAKE, Director.

Makers: C. PORTWAY & SON, TORTOISE STOVE & PORTWAY PORTABLE OVEN WORKS, HALSTEAD, ESSEX.

At the investiture at Buckingham Palace on May 17, the King bestowed the Distinguished Service Order on Major Hudson, who is in the 1-8th West Yorkshire Regiment (Leeds Rifles). Major Hudson lives at Highfield, Headingley, Leeds, and is a member of the firm of Messrs. Robert Hudson, Limited, Gildersome Foundry.

Dr. Henry Marion Howe, Professor of Metallurgy of Columbia University, New York, has just been elected an honorary vice-president of the Iron and Steel Institute. The Bessemer Gold Medal of the institute was awarded to Dr. Howe in 1895 in recognition of his great work in the advancement of metallurgical science and knowledge.

At the annual meeting of the British Foundrymen's Association on June 24, over £20 was collected towards the funds of the Royal Orphanage, with the object of securing votes on behalf of the boy of the late Mr. George Hailstone, of Birmingham. The latter was at one time secretary of the Birmingham Branch, and has contributed several papers to the Association's "Proceedings," and to those of other societies. It is hoped to secure sufficient support to have his son placed with the above institution.

Captain Henry Newton, of the Notts and Derbyshire Regiment (attached Royal Engineers), who has been awarded the D.S.O., has been responsible at the front for a number of inventions which were used to advantage by his own battalion, and afterwards by the brigade. A works was established in France for their manufacture, and Captain Newton was placed in command, and this particular works now employs a large number of men. Amongst his inventions may be mentioned a new type of hand grenade, which the Russian Army is using largely. Captain Newton is a director of the firm of Newton Bros., Limited, engineers, of Derby.

New Companies.

Woodside Engineering Company, Limited.—Capital £10,000 in £1 shares. Registered office: 50, Wellington Street, Glasgow.

Rapid Construction & Engineering Company, Limited.—Capital £10,000 in £1 shares. Registered office :—13, St. Helen's Place, E.C.

Falkirk Brass and Sanitary Engineering Company, Limited.—Capital £2,000 in £1 shares. Registered office :—Ladysmill, Falkirk.

Gwersyllt Silica Brick Company, Limited.—Capital £6,000 in £1 shares, to carry on the business of wholesale and retail manufacturers of silica bricks, etc.

Sneyd, Bycars Company, Limited.—Capital £1,000 in £1 shares, to manufacture war munitions of all kinds, etc. Registered office :—Hamil Road, Burslem.

Oliver, Ling & Company, Limited.—Capital £20,000 in £1 shares, to carry on the business of railway and general engineers. Registered office: 38, Victoria Street, E.C.

Wolverhamptor Steel & Iron Company, Limited.—Capital £15,000 in £1 shares, to adopt an agreement with J. H. Onions for the acquisition of Osier Bed Iron Works, Wolverhampton.

Burdens, Limited.—Capital £35,000 in £1 shares, to carry on the business of engineers and manufacturers of oil gas furnaces, etc. Registered office: Caldervale Works, Billshill, Lanarkshire.

Galloway Engineering Company, Limited.—Capital £40,000 £1 shares. The first directors are Major H. R. Alexander and R. H. Ballantine. Registered office :—Shakespeare Street, Dumfries.

British Graphite & Trading Company, Limited.—Capital £12,000 in 8,000 participating preference shares of £1 each, and 80,000 ordinary shares of 1s. each. Registered office: 53, Bothwell Street, Glasgow.

Bamfords, Limited.—Capital £120,000 in £1 shares, to take over the business of ironfounders and agricultural implement makers and dealers carried on by S. B. Bamford and others at Uttoxeter and Lichfield.

Brit-Alba, Limited.—Capital £1,000 in £1 shares, to carry on the business of machine and tool makers, etc. The first directors are: G. S. Albanese and W. L. Lorkin. Registered office: 2 and 3, Norfolk Street, Strand, W.C.

Torbinia Engineering Company (1916), Limited.—Capital £35,000 in 15,000 8 per cent. cumulative preferred shares of £1 each, and 400,000 ordinary shares of 1s. each. Registered office: Regent House, Kingsway, London, W.C.

W. A. Taylor, Limited.—Capital £2,000 in 1,700 founders' and 300 ordinary shares of £1 each, to carry on the business of munition manufacturers, mechanical and electrical engineers, etc. The first directors are R. E. B. Trevor and H. W. Johnson.

Regent Sheers, Limited.—Capital £2,000 in £1 shares, to carry on the business of manufacturers and suppliers of sheet-metal working machinery, etc. The first directors are J. Flower and F. Mason. Registered office :—Saint Street, Regent Street, Leeds.

Barrons (Leicester), Limited.—Capital £20,000 in £1 shares, to take over the business of engineers carried on by A. Barron and J. R. Pearson at Ryda Street, Leicester, as A. Barron & Company. Registered office: Rowton Buildings, 11, Bowling Green Street, Leicester.

Mander & Company, Limited.—Capital £2,000 in £1 shares, to take over the business of electrical and mechanical engineers, now carried on at 125, Hockley Hill, Birmingham, and to adopt an agreement with A. F. Mander. Registered office: 125, Hockley Hill, Birmingham.

Morrell Mills & Company, Limited.—Capital £30,000 in £1 shares, to take over the business of ship and engine repairers and engineers carried on by W. C. F. Bacon, J. Sivewright, and Kate Stoker at Trafford Wharf Road, Trafford Park, Manchester, as Morrell Mills & Company. Private.

George H. Alexander Engineering Company, Limited.—Capital £15,000 in £1 shares (5,000 preference) to take over the business carried on at Doe Street, Birmingham, as George H. Alexander, to carry on the business of mechanical, etc., engineers. Registered office :—34, Waterloo Street, Birmingham.

Baldwin Brothers, Limited.—Capital £4,000 in £1 shares, to take over the business of agricultural and general engineers, etc., carried on by J. Balwin, Wm. Baldwin, Walter Baldwin, and F. Baldwin, at Durgates, Wadhurst, Sussex, as Baldwin Brothers. The first directors are: J. Baldwin, W. Baldwin, and F. Baldwin.

Farrar & Young, Limited.—Capital £5,000 £1 shares (2,000 preference), to take over the business of a leather trade engineer, consulting and mechanical engineer, and machinery broker, carried on by W. Farrar at the Paragon Works, Bramley, Leeds, as Farrar & Young. The first directors are W. Farrar, T. W. Farrar, J. H. Farrar, H. E. Farrar, and G. E. Farrar.

William Ward & Son (Sheffield), Limited.—Capital £2,000 in £1 shares, to take over the business carried on at Surrey Works, Broadfield Road, Sheffield, by J. Ward, as William Ward & Son, and to carry on the business of mechanical, electrical, constructional, motor and general engineers, etc. Registered office: Surrey Works, 182, Broadfield Road, Sheffield.

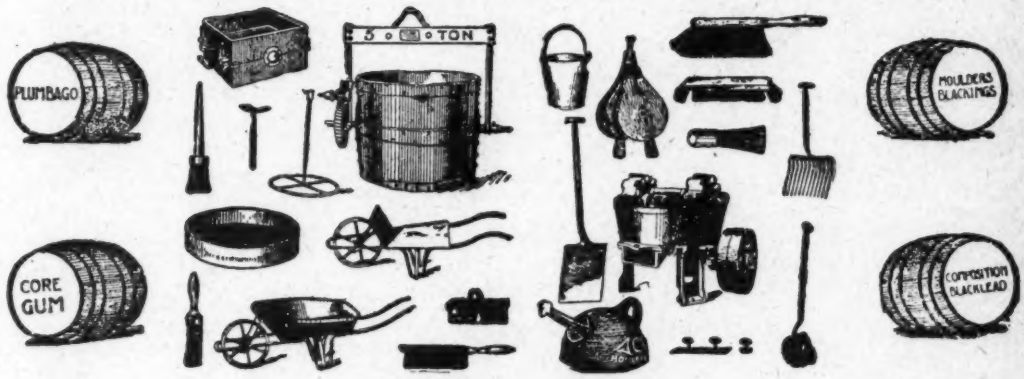
W. Brealey & Company, Limited.—Capital £2,000 £1 shares, to take over the business carried on at Love Street, Sheffield, as W. Brealey & Company, and the business carried on by J. H. Thickett, at Tenter Street, Sheffield, and to carry on the business of mechanical, electrical, constructional, motor, and general engineers, etc. The first directors are W. Brealey, J. Kirkman (Secretary), and J. H. Thickett. Registered office :—Love Street, Sheffield.

Coleman and Appleby, Limited.—Capital £3,500 in £1 shares (3,000 6 per cent, cumulative preferred, free of income-tax), to enter into an agreement of sale and purchase between Langbein-Pianhauser Works, Limited, and W. Randle, the Controller thereof, of the first part, O. J. Neale, W. R. Baker, C. B. Appleby, and H. S. Coleman of the second part, and T. J. B. Hasell (for the company) of the third part, and to carry on the business of electro-metallurgists, etc. Registered office: 23, Great Hampton Street, Birmingham.

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



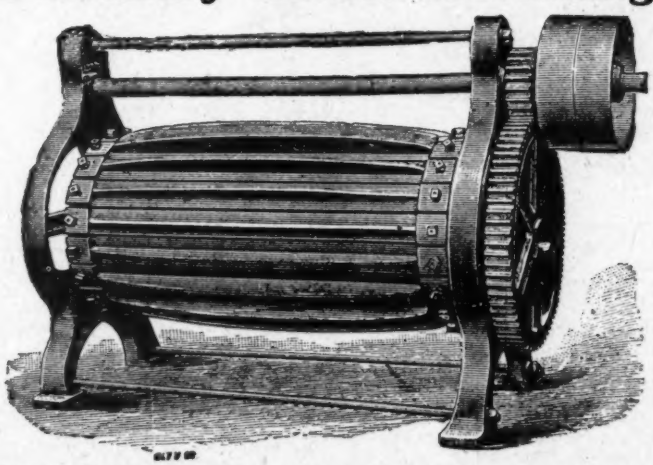
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining at the commencement of the current month.

CONTROL PRICES.

These maximum prices of iron, steel and coke were fixed by the Government until June 30, 1916, and thereafter until further notice. Makers may sell for delivery after June 30, on the understanding that the fixed maximum prices ruling on the 1st day of any month during the period of the contract will apply to all deliveries made during that month. This intimation must not be taken to authorise any sale or purchase or other dealing prohibited under the Defence of the Realm Regulations.

Pig-Iron.

	£	s.	d.
West Coast hematite, mixed Nos., 1, 2 and 3	6	7	6
Special under 0.03 P & S	6	15	6
„ „ 0.02 „	7	0	0
East Coast hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.03 P & S. ..	6	15	6
„ „ 0.02 „	7	0	0
Scotch hematite, mixed Nos. 1, 2 and 3..	6	2	6
Special under 0.03 P. & S. ..	6	15	6
„ „ 0.02 „	7	0	0
Welsh hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.03 P. & S. ..	6	15	6
„ „ 0.02 „	7	0	0
Lincolnshire, basic or foundry ..	4	7	6
Cleveland, mixed Nos. 1, 2 and 3..	4	7	6
Northamptonshire, forge	4	2	6
„ foundry numbers	4	5	0
Derbyshire, forge	4	5	0
„ foundry numbers ..	4	7	6
Leicestershire, No. 4 forge ..	4	5	0
„ No. 3 foundry ..	4	7	6
North Staffs, forge	4	10	0
„ „ foundry	4	12	6
„ „ basic	4	15	0
South Staffordshire—			
Part mine forge	4	10	0
„ foundry	4	12	6
Common Staffordshire ..	4	5	0
All mine forge	5	10	0
„ foundry	5	15	0
Warm air forge	7	0	0
„ foundry	7	10	0
Lord Dudley's silicon	7	17	6
Cold blast	8	17	6
Scotch foundry and forge—			
Nos. 3, 4, and lower grades of Monkland, Dalmellington, Eglinton, and Govan.. ..	5	14	0
Nos. 3, 4, and lower grades of all other brands	5	15	6

No. 1 quality in all cases to be 5s. per ton above these prices.

All per ton net, f.o.t. makers' works.

High-Speed Tool Steel.

The maximum prices for high-speed tool steel have been fixed as follows:—

Finished bars, 14% Tung. 2s. 10d.

Finished bars, 18% Tung. 2s. 10d.

Per lb. basis. Usual trade extras for special sizes, etc. These prices are net delivered buyers' works.

The fixed prices for scrap which must be returned to steel makers' works are as follows:—

Millings and Turnings	5d
Bar Ends	6d

Both per lb. net delivered steel makers works

Ferro-Alloys

Net, Delivered Sheffield steel works.

	£	s.	d.
Ferro chrome: 4/6% carbon. Basis 60%, scale 10s. per unit Per ton	38	0	0
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	36	0	0
Ferro-chrome: 8/10% carbon. Basis 60% scale, 10s. per unit Per ton	34	0	0
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon broken to small pieces for use in best quality crucible steels. Basis 60%, scale 32s. per unit. Per ton	120	0	0
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy	0	15	0
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit .. Per ton	27	10	0
Ferro-titanium: 23/25%, per lb. carbonless..	0	1	5
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained ..	0	16	0
Ferro-phosphorus: 20/25%. Per ton	16	10	0
Ferro-tungsten: 75% to 80% per lb. of metallic tungsten contained	0	6	1
*Ferro-manganese 80%	25	0	0
„ export 30 0 0—40	0	0	

* F.o.b. Liverpool.

Non-Ferrous Metals.

	£	s.	d.	£	s.	d.
Copper.						
Standard, Cash	101	15	0	102	5	0
Three months	97	15	0	98	0	0
Electrolytic	134	0	0	130	0	0
Tough	125	0	0	127	0	0
Best selected	126	0	0	128	0	0
Tin.						
Standard, Cash	172	5	0	172	10	0
„ Three months	172	15	0	173	0	0
English Ingots		—		176	0	0
Bars		—		177	0	0
Refined		—		179	0	0
Spelter.						
American	56	0	0	57	0	0
Specials		—			—	
Hard	45	0	0	48	0	0
British		—		58	0	0
Lead.						
Soft Foreign		—		28	5	0
English		—		29	10	0
Antimony.						
Regulus		—		95	0	0
Aluminium.						
Virgin Metal 98/99% per ton	155	0	0	200	0	0

Phosphor Bronze.

INGOTS.	Per ton.
Alloy No. I. or II.	—
III., IV. or V.	—
VI. or VII.	—
VIII.	—
XI.	—
Cast Strips and Ingots..	—
CASTINGS.	Per lb.
I. or II.	—
III. IV. or V.	—
VI. or VII.	—
VIII.	—
XI.	—
No. VII., Chill, Cast, Solid	—
„ Cored Bars	—

Delivery 2 Cwt. free to any town.

10 per cent. Phosphor Copper .. 35/- above price of best selected copper.

15 per cent. Phosphor Copper .. 40/- above price B.S.

Phosphor Tin (5 per cent.) .. £23 above Price of English Ingots.

(Phosphor-bronze prices supplied by CHARLES CLIFFORD AND SON, LIMITED, FAZELEY STREET MILLS, BIRMINGHAM).

***Chromium (Metallic).**			
98/99% purity, per lb.	—	0	5 9
***Nickel.**			
In cubes, 98/99% purity Per ton	220	0	0

Nickel Silver.

	per lb.
Ingots for raising ..	..2/0 to 1/6
Ingots for Spoons and Forks	..2/0 to 1/5½
„ rolled to spoon size	..2/1½ to 1/7

***Tungsten Metal Powder.**			
96/98% purity.. per lb. ..	0	6	3
***Molybdenum Metal.**			
96/98% purity.. per lb. ..	—		
***Cobalt Metal.**			
97% purity .. per lb. ..	0	7	6
Quicksilver.			
75 lb. bottle	16	13	9

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s.	d.	s.	d.
Steel scrap, heavy melting..	100	0 to	102	6
Iron scrap cast (cupola metal)	75	0	77	6

London (f.o.b.).

Heavy steel	95	0	
Light „	50	0	
Heavy cast	95	0	

Non-Ferrous Scrap.

London merchants quote the following prices for scrap metal, delivered London, and subject to market fluctuations:—

	A. Joseph. £	s.	d.
Hy. Electrolytic Copper Scrap	..120	0	0
Hy. Selected Scrap Brass	.. 75	0	0
Hy. Tinned Copper Wire ..	..110	0	0
Best Selected Gunmetal Scrap	.. 92	0	0

Re-melted Ingot Lead 30s. under English Lead price on date of order.

Stocks.

Metals.	Tons.
Copper, Europe and afloat	13,828
Tin, London, Holland, U.S.A. and afloat	20,975

Coke.

Middlesbrough.

	s.	d.	s.	d.
Gas Coke	35	0	37	6

Cardiff.

	s.	d.	s.	d.
Special Foundry Coke ..		—		—
Foundry Coke		—		—

Glasgow.

Foundry Coke	39	0	42	0
Furnace Coke	36	6	—	
Gas Coke		—	—	

London.

Welsh or Durham Foundry, d/d London Stations in truck	45	6	53	0
Ditto, d/d Birmingham Stations	44	0	48	0
Yorkshire, d/d London Stations, in truck	42	6	—	
Ditto, d/d Birmingham Stations	39	6	—	

CONTROL PRICES OF COKE.

	s.	d.
Durham blast furnace	28	0
„ special ditto, guarantee under 0.008 phos... ..	30	6
„ foundry	30	6
South Yorkshire, West Yorkshire, North Staffordshire, and North Derbyshire	24	0
South Wales blast furnace	30	0

All per ton net f.o.t. ovens.

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POSITION Wanted, as Foreman or Assistant, by Moulder (age 30); well up in all foundry subjects; good practical training; excellent knowledge of metallurgy, etc. Good reference as to character and ability. —Address, Box 822, Offices of the *Foundry Trade Journal*, 165, Strand, London, W.C.

FOREMAN Pattern Maker or Shop Superintendent seeks position with larger opportunity, where the services of a capable organiser and disciplinarian with wide experience in varied lines can be utilized.—Apply Box 824, Offices of *Foundry Trade Journal*, 165, Strand, London, W.C.

WANTED, for Factory near London, several First-class Draughtsmen, thoroughly accustomed to the design of heavy motor road vehicles (petrol).—Apply, stating age, experience and salary required, to nearest Labour Exchange, mentioning No. A. 1971.—Application from men at present employed on Government work will not be entertained.

MOULDERS (Aluminium) required for immediate Government work. Experienced men used to high-class petrol motor work. Good wages and prospects, War bonus and overtime. No man on Government work may be engaged.—Write or apply in first instance to your nearest Board of Trade Labour Exchange, mentioning this paper, and No. A. 2015.

WORKING Foreman wanted for small Brass Foundry just starting in New Engineer's Works near London.—State experience, salary, etc., Box 826, Offices of *Foundry Trade Journal*, 165, Strand, London, W.C.

WANTED, a FOUNDRY FOREMAN for light steel castings. — State age, experience, and salary required, Box No. 830, Offices of *The Foundry Trade Journal*, 165, Strand, London, W.C.

ASSISTANT to Foundry Manager in a General Jobbing Foundry in the Lancashire district, where all classes of work is undertaken. Applicants must have had control of large numbers of men, and good experience in organisation and up-to-date shop practices; the position offers good opportunities to the right man. State full particulars, only copies of testimonials to be sent; all applications will be treated strictly confidentially.—Apply Box 828, Offices of *Foundry Trade Journal*, 165, Strand, London, W.C.

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ONE good Second-hand No. 2 Roots' Blower, belt-driven both ends, about 12in. pulleys, good gearing, 8 in. diameter outlet underneath, wooden vanes, ready for prompt delivery.—MARPLE & GILLOTT, LIMITED, Sheffield.

FOR SALE.—24-in. Invincible Sand Mixer, capacity 3 tons per hour, for grinding, mixing and screening foundry sands, at lowest cost per ton.—Apply, HALL, 26, Paradise Square, Sheffield.

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STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips: also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
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38"
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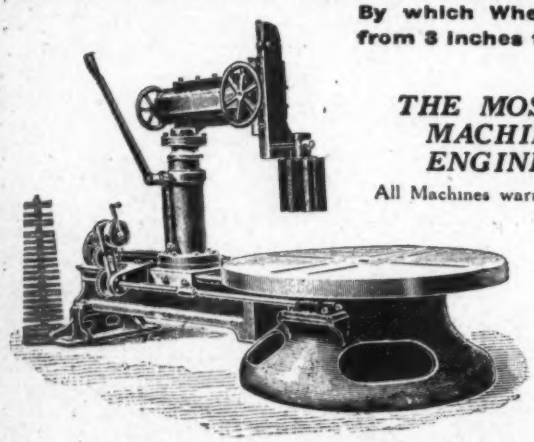

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	Alldays & Onions, Ltd.	Birmingham	Alldays, Birmingham	28 Victoria
403	Anglo-Mexican Petroleum Products Co., Ltd.	Finsbury Court, Finsbury Pavement, E.C.	Mexproduct, Ave, London	City 2704
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397	Naish & Croft	150, Alma Street, Birmingham	—	—
418	Olsen, William	Cogan Street, Hull	Wm. Olsen, Hull	Nat. 1184
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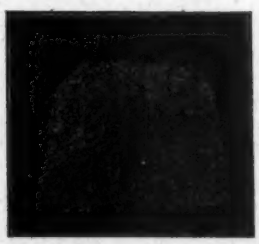

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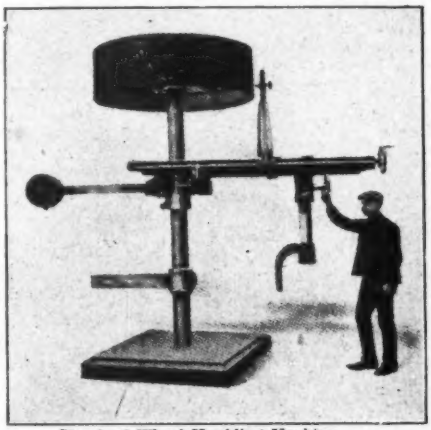

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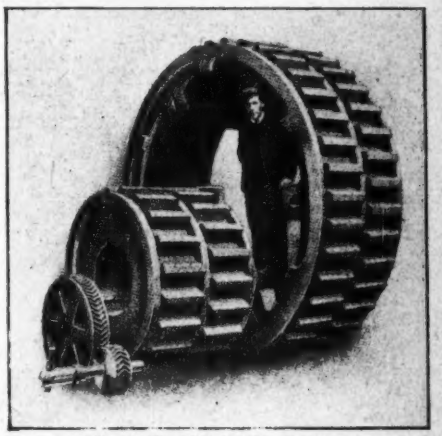

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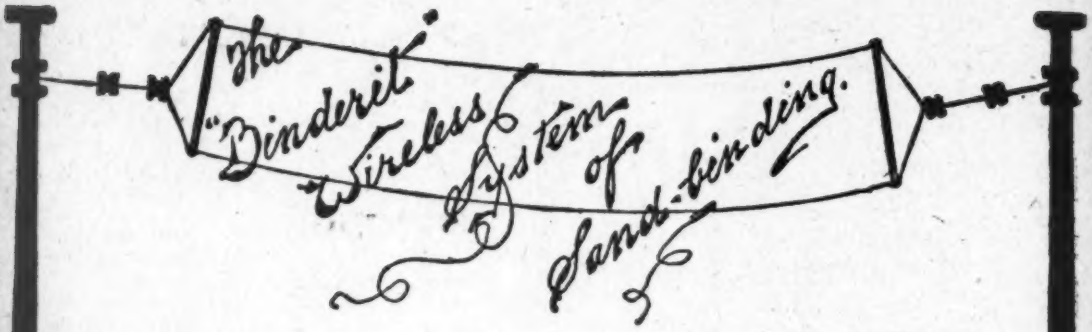

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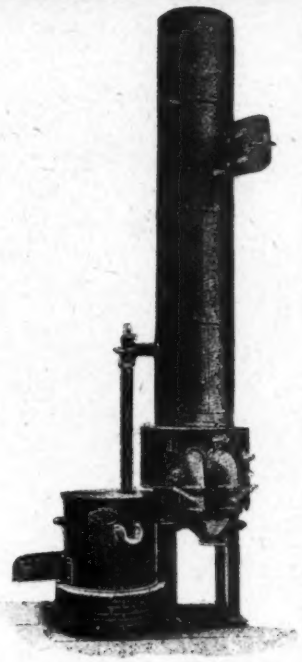

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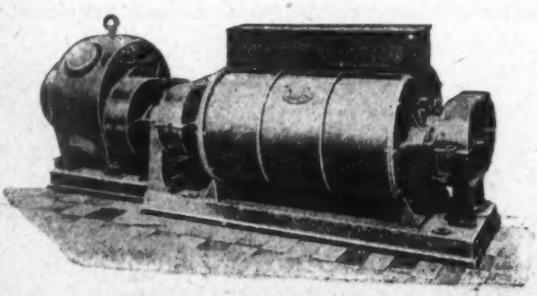

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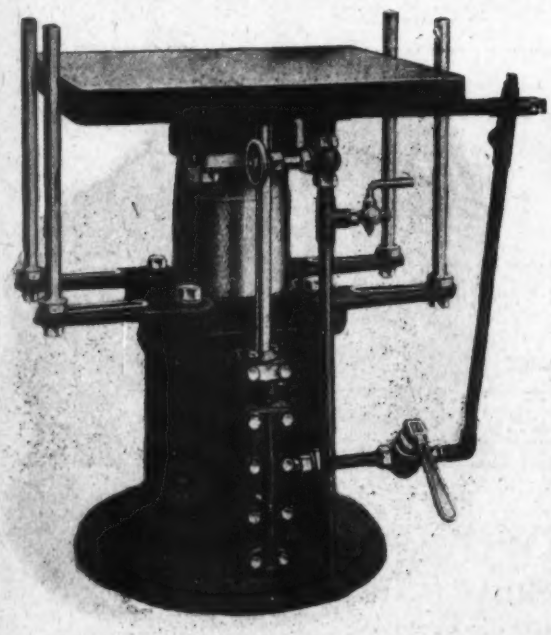

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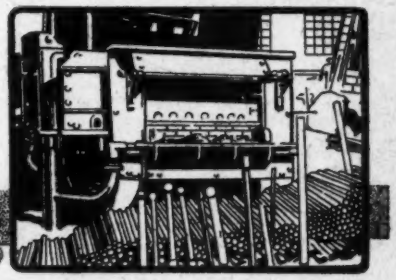

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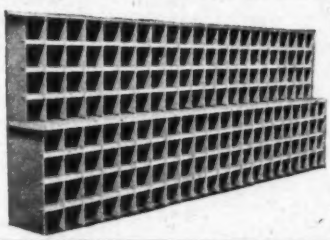

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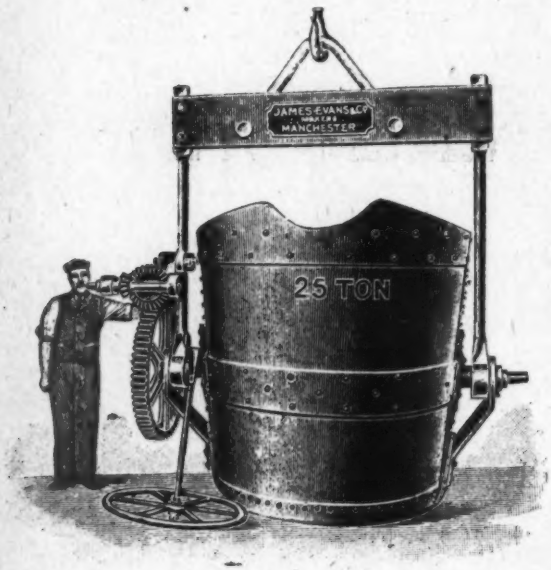

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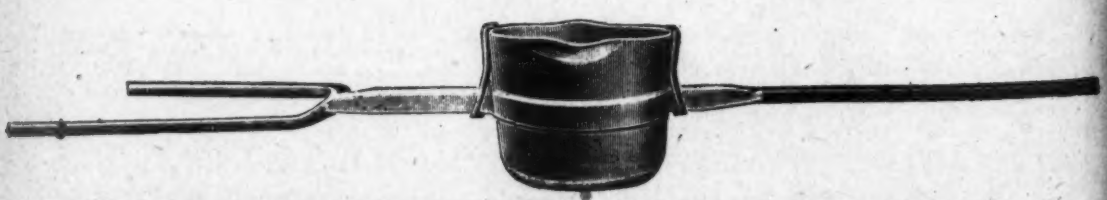

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